CHILD AND UNIVERSE

LIBRARY OF PRINCETON
JAN 9 1947
THEOLOGICAL SEMINARY

LB1585
.S84

Child and Universe

Digitized by the Internet Archive
in 2024 with funding from
Princeton Theological Seminary Library

https://archive.org/details/childuniverse00stev

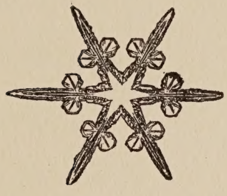
Cornelia Clarke

PEARLS FROM THE MISSISSIPPI RIVER

LIBRARY OF PRINCETON
JAN 9 1947
THEOLOGICAL SEMINARY

Child and Universe

by Bertha Stevens



New York
The John Day Company

Copyright, 1931, by Bertha Stevens
All Rights Reserved

This book was printed in the United States of America,
the illustrations by the Printing House of William Edwin
Rudge, Mt. Vernon, N. Y. and the letterpress and binding
by the Quinn & Boden Company, Rahway, N. J.

Contents

Introduction ix

Synopsis of Text xiii

I. Why Study the Universe? 3

II. Principles and Methods 18

III. The Earth in Space 45

IV. The Inside of the Earth 81

V. The Earth's Surface 114

VI. The Earth's Atmosphere 158

VII. Beauty and Rhythm 183

VIII. Articulation with a Curriculum 232

List of Illustrations

Pearls from the Mississippi River *Frontispiece*

OPPOSITE PAGE

Lady fern, the underside of the leaf 4

Foxglove 10

Agate landscapes 14

Tracks in sand 18

Hen and chickens 22

Thistle leaf rosette 26

Dragon-fly and water-lily 30

Nest of the yellow warbler 34

Bog rhubarb 40

Spiral Nebula in Ursa Major 46

Brooks' Comet 52

Dandelion head in fruit 58

Dandelion fruits ready to sail 64

Hexagonal cells made by wasps 70

Cowfish decorated with a design of hexagons 76

Fossil fern fronds 84

Common garden seeds 92

Pyrolusite in slate 100

Quartz crystal 106

Calcite crystals 110

Horsetail, architectural in its suggestion 116

OPPOSITE PAGE
Underside of the oyster mushroom 122
Flower-like fungi on decaying wood 126
Fossil shells 132
Wind ripples in sand 138
Mountain laurel 144
Jelly-fish 150
Cirrus clouds 158
Dew-drops on a spider-web 164
Frost on a bachelor-button leaf 166
Tiger moths 174
Gulls in flight 176
Luna moth 184
Snowflakes 188
Water-lily 192
Wild rye 196
An ear of corn 200
Margined pyramidal saxifrage, rosette 204
Shield fern, spiral fronds 208
Snail shell, spiral 210
Spiraling tendrils of a squash plant 212
Copper in dendritic form 214
Spider-web, radial, spiral and catenary curves 216
Willkomm's saxifrage, rosette 220
Dynamic symmetry in the pine cone 224
Leaf skeleton 228
Rhythmic drawings 230

Introduction

THIS book has to do with children, education and natural science. It seeks to promote the development of children through science education; but it is in no sense a science text-book. It is designed to be useful in the home; not as a program which parents will carry out, but as an aid to them in being open and responsive when their children come to them with questions and observations about the universe—as children are sure to do no matter what their school experience may be.

To the extent that the book addresses teachers, the grade or group teacher rather than the elementary science specialist is thought of because the work of the group teacher has greater opportunity to permeate and motivate the school experience as a whole. The book seeks to give practical, detailed help to the group teacher who desires to include the values set forth. It endeavors to provide subject information in so far as this is needed to bring out the teaching purposes and methods; and the information given has been supplemented with page references to easily available source books and texts which can supply specific needs.

The book is, primarily, the exposition of an idea which I hope will find its way to the consideration of the makers of primary school curricula. It offers a plan whereby natural science becomes the core of education for two successive years, and it suggests a way for articulating the work of these years with that of the years which precede and follow. It treats natural knowledge not as a teaching subject but as a force acting through human life, helping to explain it and giving it quality. It states reasons for opening up this experience to children in early primary years.

Nature counselors in children's camps may find in the book specific suggestions which they can adopt; but of course piecemeal use of the book cannot hope to bring out its purposes as consecutiveness and wholeness can.

The experience of working with children in this field has been an inspiring one. Through the use of quotation and the mode of approach to subject matter I have hoped, in the written account, to convey something of the meaning of this. The spirit may soar inevitably, yet with reason and with safety, if the feet are firmly grounded. Universal poet and scientist find a meeting place in common. Man has a right to be informed concerning the universe and also to be thrilled with it; and the first experience can lead to the second.

I hope this book will promote in the reader conscious awareness of the unfolding order and beauty of the cosmos, and that it will give him a strengthened desire to share his experience with children and to go on and on with them to greater realization.

The experiences which the book describes have occupied the past nine years. The work was begun at Carson College, Flourtown, Pa., and has been carried on recently at the Avery Coonley School, Downer's Grove, Ill.

The manuscript was read, in part, by Miss Flora J. Cooke and Miss Elsie Wygant of the Francis M. Parker School, Chicago. They made helpful suggestions which I have tried to incorporate. Acknowledgment is made to Nature Magazine for information and other help in connection with illustrations.

BERTHA STEVENS.

Synopsis of Text

I. WHY STUDY THE UNIVERSE?

Every individual a part of a unified creation and a cosmic system — The mind expanded and the spirit made more free through awareness of daily cosmic experiences — The readiness of children of primary years to reveal their spiritual nature — Primary years found to be receptive, and mentally equal, to thought about the universe — The earth as a whole, in aspects of lithosphere, hydrosphere and atmosphere, accepted as the starting point for universe study — The place accorded to man — Fundamental concepts of creation — Wonder and beauty; J. Arthur Thomson quoted — Scientific inquiry versus ethical interpretations — Values which universe study may bring to individual experience

II. PRINCIPLES AND METHODS

A two-year program for primary grades — Considerations which affect the selection of topics and methods — Guiding principles in teaching: (1) Making values the objective and subject matter the means (2) Recognizing the readiness of primary children to respond to beauty and other spiritual values (3) Recognizing that the spontaneous approach of children to new experiences is through feeling, which searches out quality and essence; that this is followed normally by observation and experimentation, and a demand for accurate factual information which should be met (4) Recognizing the need for children to go slowly, taking time to live with ideas (5) Recognizing the need for constant clarity in the mind of the teacher with reference to facts and teaching objectives (6) Finding in the mental attitude of the children an index to the effectiveness of the teaching (7) Recognizing the need to let children live vitally in the present; to let them know their world in aspects of both day and night, and to play with it in all the opportunities which wind, weather and natural surroundings provide (8) Regarding the integrated realization of a flower, a crystal, or other objectification of nature as more important to childhood than analysis and labeling (9) Recognizing basic value in uncovering to thought evidence of natural law, such as the operation of gravity, sequential development, and instances of mathematical precision (10) Making clear distinction between first- and second-hand knowledge; between actual occurrences and conjectured or imagined ones

Methods and devices: The use of simple scientific tools and playthings such as magnifiers, prisms, magnets — The use of texts, lectures and literature — The relation of poetry to universe study — The use of visual material — Children's contributions of illustrative material — Play and dramatization — Written statements by children to insure clarity — Children as teachers; school assembly programs; contributions made by visitors — The use of drawing, in part, as a form of recitation and a means of record making — The place of universe study in a daily time schedule — Outlets for creative expression — The teacher's equipment

III. THE EARTH IN SPACE

Suggestions for bringing out thoughtfulness, reverence and beauty in starting this study — Ways of developing consciousness of the heavens — Topics for consideration

— Getting acquainted with the globe of the earth — Use of a globe, and of soap bubbles and balloons in establishing a concept of worlds in space — Consideration of the origin and the movements of planets and satellites — Imagining a journey from the earth to another planet — Dramatization of the solar system; of the relations and movements which cause the earth's day and night, its seasons, its months — Use of dyed silk scarfs in rhythmic pantomime — Use of clay spheres and other mechanical devices — Direct observation — Observatory and museum — Use of lantern slides and stereographs — Play with magnets

The sun: children's experiences of the sun and sunlight; ideas of radiance and reflection; shadows, blue prints, sun-dial; prism, spectrum, rainbow; recognition of the relation of light to life — The moon: children's experiences of the moon and moonlight; Japanese Hokku poetry; study of the moon's surface; observation and drawing of the cycle of the moon's phases — The stars: theories of the children, and of astronomers, concerning what stars are; observation of stars and discussion of the thoughts they inspire and the appearances they present; scientific information concerning the number, distance, size, age, brightness, location and grouping of stars; simplicity, through elimination, a guiding rule in star teaching; the use of box transparencies to illustrate constellations and other groupings; photography of star trails

Developing the consciousness of space, time, order, rhythm, and sequence — Suggestion of media for expressing creative ideas resulting from study of stars — The linkage between scientific knowledge and poetic consciousness — Rhythmic pantomime — The relation of Walt Whitman's poetry to a summary of values

IV. THE INSIDE OF THE EARTH

This subject a logical sequence to the subject of the preceding chapter — Speculation concerning the earth's interior — Imparting facts by imagining a journey through the center of the earth — Earthquake and volcano — A concept of the inside of the earth as a storehouse of supply for the material needs of living beings — Games which develop this idea — Speculation concerning undiscovered stores — Topics included in a study of the earth's interior — The origin of soil — Making a mechanical analysis of soil — Comparisons of the soils of different localities

The relation of soil to plant growth: Observation and study of seeds, with relation to color, form, design, modes of dispersal and germination — The drawing of the seed cycle — Observation and study of the types and habits of roots — The relation of roots to plant life — The realization of a plant as a whole — A tree's awakening in spring — The drawing of the cycle of tree feeding

Animals' use of the underground: The work of earthworms — Suggestion of sources which provide descriptions of weasel, fox, woodchuck and other burrows — Dramatic play resulting from consideration of the ways of animals that live underground

Ground water: Making a chart of its sources and travels — Consideration of wells, springs, geysers, caves, and later of ore veins

The earth's mineral stores: Playing with crystals and crystalline stones — Incidental observation of crystal form, color, texture, play of light and other qualities — Use of Ruskin's crystal game — Making crystals of salt, sugar, alum — Study of jewels and of gem cutting and setting — Use of tripod magnifiers to bring out structure and beauty — Imaginative play with magnifiers and minerals — Drawing or modeling crystal forms, and making paintings of crystals and other stones, to aid awareness of structure and appreciation of beauty — Study of mines, quarries, oil wells, gas wells — Drawing the coal cycle — Development of interest in common neighborhood stones, in seashore and lakeshore pebbles, in fossils — Exchanges of minerals between children of different localities — Neighborhood excursions and museum visits — Making plasteline hemisphere maps to show in what regions of the earth the principal mineral resources are found — A summary of the values which can be realized in this study

V. THE EARTH'S SURFACE

The earth ball seen in panorama: Jane Andrews' picture of surface contrasts — The panoramic poetry of Whitman and other writers — A game with a globe to imagine the whole surface of the earth and its continuity — The consideration of latitude and longitude and their relation to map drawing — Map games which aid understanding and knowledge and stir the imagination concerning the as-yet-unknown — Suggestion of topics for study

Forest and woods: A children's exhibition of woods treasures — Woods games, occupations and free play which help children to appreciate and love the woods — Study of little woods animals and resultant play and dramatization — Learning about the woods through watching and waiting — Getting acquainted with trees — Making large rhythmic drawings of trees

Rocks: Observations of formations and surface appearances, directly and with the aid of photographs, lantern and stereoscope — Neighborhood excursions to seek illustration of igneous, sedimentary and metamorphic rock — Impressions of solidity and grandeur, and architectural and sculptural effects — Reference to Ruskin's rock descriptions and the ideas of exquisite beauty and variety which these convey — Study of the making and wearing of rocks — The rock cycle — Vocabulary gained through rock study

Mountains: Ways of conveying a concept of mountains to children who have not seen them — Play and dramatization resulting from consideration of mountains and including climbing, trail making, yodeling; beholding imaginary views, hearing echoes — Photographic and literary aids to realization of the strength, majesty, beauty, and seeming stillness and permanence of mountains — Study of the principal types of mountain origins — Use of map or globe in illustrating and locating these — The mountain cycle — Making a large wall, or floor, map of the earth in hemispheres, showing the principal mountain systems of the world in relief — The use of this map throughout the school year, adding other physical world features from time to time — Creative modeling of mountains, and drawings and paintings on a scale large enough to allow long, rhythmic mountain lines — Rhythmic pantomime

Rivers: Facts learned unconsciously through river or brook play — The adventuring aspect of a river and its ceaseless activity — Study of the origin, course and destination of selected rivers — Study of watersheds and river systems — Adding to the wall or floor map the river systems of the world — Study of the geological importance of rivers

The sea: Ways of realizing its might, vastness and grandeur; the application of rhythm training — Sea and sand play — Enjoyment of sea weeds, shells and other sea treasures — Map study of surface shapes of oceans — Study of the relief and depth of ocean beds, of foraminiferal deposits, of the origin of islands — Study of coast line changes; of the movements of wave, tide, current — Tracing on the wall or floor map the cyclic courses of the principal currents, and locating Sargasso Seas — Creative results of study as expressed in large and small paintings

The Window of the World — Restatement of fundamental concepts regarding interrelations, rhythm, and sequential development

VI. THE EARTH'S ATMOSPHERE

The sky, and human experience — The beauty of cloud forms — Sky pictures — Cloud experiences from an airplane — Topics for study — Facts about the atmosphere which children can understand

Moisture: Illustration of evaporation and precipitation — Understanding of vapor, steam, cloud, fog, mist, rain, sleet, snow, hail, dew, frost — The study of cloud forms — The painting and photographing of cloud aspects — The moisture cycle; making rainfall charts — Observation of snow crystals, of frost forms, of dew-drops — Understanding of thunder and lightning and northern lights — Shelley's scientific account of atmospheric moisture

Wind: The use of chart and map to show the cause of prevailing westerlies and trade winds and their cyclic movement — A classification of winds based on strength and velocity — Work of the wind — Wind playthings: balloons and kites — The beauty and prevalence of wind-caused movements

Fire (explained in text): Simple experiments leading toward understanding of combustion — Observation of flame and smoke — Safe and interesting ways of playing with fire — Creative expression

Winged Life: Observation of the flight of insects and birds — Reference to bird flight in literature and texts — Children's inner response to flying — The mechanics of bird flight — Observation and study of the beauty and variety of bird feathers; making blue prints of these — Study of flock movement and flock formations — Burroughs' theory regarding simultaneous flock movements — Study of the phenomenon of migration — The practice of bird banding — Indicating bird travel routes on the wall map of the earth — Summary of concepts gained through atmosphere study

VII. BEAUTY AND RHYTHM

Universal aspect of beauty — The persistence of early impressions — Beauty regarded as essence: the relation of this idea to seeing resemblances; to the use of simile and metaphor — Awareness of an inner consciousness — The capacity of children to store impressions; verbal expression of beauty called out by single, suggested words; group descriptions — The Japanese view of natural beauty — Ways of developing in children the consciousness of beauty: the use of magnifier, artoscope, shadowgraph, blue print — Grasses, an illustration of beauty in every-day surroundings — Nature's pageants — The relation of beauty and art — Analysis of the fact of beauty — The modern tendency to establish or revive laws of beauty — Nature's effects through color and light — The mathematical base of proportion and form as illustrated statically by the snow crystal and dynamically by the pine cone — Multiplicity of forms — Children's observations and explorations regarding form in nature; identification or discovery of numerical series and of geometric figures such as triangle, hexagon, or sphere — Radials and rosettes, concentric circles, catenary curves, and dendritic form — Special consideration of the spiral

The relation between an individual's consciousness of rhythm and his response to beauty; the tendency of children to store impressions of movement — The pervasive rhythm of the universe, as seen in the movements of bodies in space, in topographical changes in the earth's surface, in plant growth, in movements of sea and wind, in the flight of birds — Symmetrical form a record of rhythmic growth and functioning — Distinction between natural rhythmic movements which are apprehended through information and those which can be observed — The movements of animals — Rhythmic movements which recur in children's play and adults' occupations — Rhythm defined — Analysis of typical rhythmic movements in nature such as radiating, undulating, up and over, up and off, circling, spiraling — The relation of rhythm training to an individual's realization of the cosmos; to his freedom of expression, his physical coördination and effectiveness — Natural dance — Dance patterns from both inanimate and animate nature — Line-drawing as a mode of reducing form and action to their basic rhythmic character — Laws of Japanese painting — Rhythmic drawing on a large scale — Recognition of rhythm as a basic factor common to all the arts — The relation of developed rhythm consciousness to creativeness, and to vital appreciation of rhythmic art expression

VIII. ARTICULATION WITH A CURRICULUM

The necessity for a curriculum plan to evolve from some basic idea — All man's thoughts, relations, activities and means of sustenance comprehended in the trilogy "God, Man and the Universe" — Man and the universe, in terms of social science and natural science, recognized as vital, basic subjects for a plan of education — Necessity for keeping always present the values inherent in both subjects, although the relative apportionment of time and the method will vary with the age and development of the children — Considerations which affect the choice of subject material for the primary grades — A central subject interest and specific values for each school year — The upper school — A curriculum plan, by grades, for social and natural science study — Anchorage in space and time — Educational factors which the plan as outlined may be expected to include — The need to take care of all real values without overdue insistence upon obvious correlation — Reference to Mr. A. N. Whitehead's Rhythm of Education and his theory regarding ages of romance, precision and generalization in specified fields of study — Two ideas current in modern schools for subject matter for second and third grades — The value of these ideas estimated — Second and third grades regarded as offering the most favorable opportunity for relating a child consciously to the wonder, order and beauty of the coördinated cosmos of which he is part — The view that universe study has high social value in its capacity to make finer individuals — The significance of mathematics — Summary of the values of the suggested course of study; also of those stated by the book as a whole — Realization that man and the universe are parts of one coördinated system; that in the largest sense social and natural science are one, interwoven whole

Child and Universe

I.

Why Study the Universe?

TWO facts which pertain to every person are these: he has been born into a universe, or unified creation; and he is part of a cosmic system. These facts govern the lives of all individuals, although they may be apprehended by those individuals in varying degrees. Those who become scientists or poets indicate by their vocation that they may have a special measure of apprehension. So also may others whose lives appear to their friends to have well-springs of happiness not derived from persons or special circumstances, and mental resources which lead them to find beauty and interest on every side.

How much awareness has the man on the street of the operation of law in the natural universe, of the endless exemplifications of beauty and rhythm in it, of its unfolding wonders of organization and form, of the varieties and the range from minutiæ to magnitudes? This should be one of the questions whereby general education tests itself. Until the concepts of the oneness and order of creation, of its resources for thought and its revelations of beauty and other values are vital, continuing presences in the consciousness of any normal person who has been exposed to formal education, this education has failed to fulfill one of its major purposes.

Cosmic experience is a daily and nightly fact. Within the observation of all, and only needing to be recognized as of cosmic import, are such bodies as the sun, moon and stars; and many can see the meteorites placed on view in public museums. The cosmic phenomena of day and night, the seasons, the equinoxes, equatorial and polar climate, the phases of the moon, the tides, the eclipses, and the changing positions of the planets are at hand for the contemplation of almost everyone. The root cause of the expanded but calm feeling one has in looking at the stars and of one's application of large terms like "grandeur," "splendor," and "glory," to the appearance of sunrise and sunset, is the cosmic aspect involved.

Other cosmic factors known or indicated to the scientist are the significance of the study of the atom to both smallest and greatest physical manifestations; the existence of identical chemical elements in the earth and other bodies in space; the apparent coincidence of sun-spot disturbances and magnetic storms on the earth; the occurrence of identical geometrical forms on the earth and in the heavens; the all-pervading force of gravitation; polarity; and the constant principle of sequential development. Light, to the scientist, is a cosmic messenger traveling through the incalculable reaches of space.

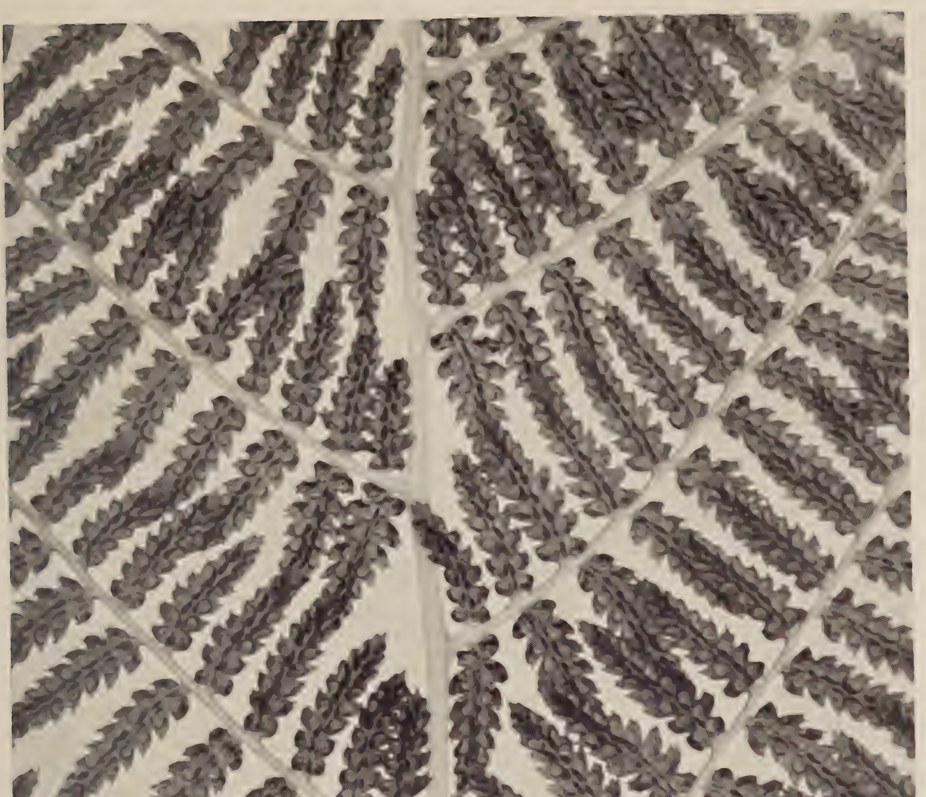
The rhythm of the cosmos is a factor of it which can be observed or revealed to thought, in countless instances. But better than this, it can be experienced in the individual's consciousness as a movement which he shares. He is part of that "general rhythm that marks not life only, but the universe." [1] A poet, on one rare day when his consciousness of being at one with the natural order transcended that on other days, looked up at the waving boughs and found that he was swaying in unison with them. It is possible that "the delight that most children take in swinging is the outcome of natural, physical craving to be in line with nature's forces." [2]

Awareness of universal environment and man's relation

---

[1] Havelock Ellis: The Dance of Life. Houghton Mifflin Co., 1923. p. 37.

[2] Mary Everest Boole: Preparation of the Child for Science. Clarendon Press, 1904. p. 65.



L. W. Brownell

LADY FERN. THE UNDERSIDE OF THE LEAF WITH ITS SPORANGIA PROVIDES AN ARRESTING DESIGN

to it can be established in an individual's consciousness through a right process of education. By proof of experience I am convinced that the years before ten years of age, specifically the ages of seven, eight and nine, are receptive to teaching in this field and mentally equal to it; and I believe that the results attainable can not only be lasting but can increase automatically with added years of living. For the earth-born, the subject of such teaching is logically the earth, considered in its wholeness and as part of a greater whole.

Earth study, I believe, should begin at the earliest age when normal children first look beyond their immediate, personal experiences and ties to the world about them; and I believe it should never end. But in order that it may be introduced to children with the wholeness of concept already referred to, it should, I think, be assigned a place of major importance in a school program for two consecutive years beginning when children are seven or eight years old. Normal children of these ages are asking, "How far is the sky? What is above it? Would the stars still look like little lights if you could go right up to them? Where does the sun go when we don't see it any more? What is on the other side of the moon? Why does it change its shape? If you walk and walk and never stop, what would you get to? If you dig and dig would you really come to China? Do stones grow? Why does a seed make flowers?" If children are thinking questions like these and, encouraged by adult receptiveness, asking them, only the truth as scientists supply it will meet their need and be fair to their mental attainment. Seven and eight, therefore, I believe are the right ages for starting earth study, for letting in the small end of the wedge that should widen in its course throughout all living.

In these early years the purpose of awakening thought can be served; and the way should be prepared for vitally interested application, later, to more intensive study. Children at this period are truth-seekers. They are simple, direct and eager; with freshness and expectancy they approach a world sighted but unexplored. The years seven, eight and nine are golden years of receptivity and unselfconscious responses. They are the years, perhaps, when the spiritual nature of children most readily manifests itself. They are golden years of playing, exploring, dramatizing, observing, and of unsophisticated thinking. One who has worked with children of these ages probably knows that if he himself wants a fresh, imaginative, poetic, detached or clear view of some matter within children's powers of comprehension, and the matter is put before them, the responses of the children are not likely to be disappointing.

The study of the earth evokes and arrests thought and gives it wings. It brings children into the realm of what is unchangingly true and basic for all people everywhere under the sun; and it provides on every side concrete illustration of the cosmic order. It opens up vistas of wonderfulness and beauty. It makes children desire to be active in knowing the truth, because they have had a glimpse of some of the rewards.

Mr. J. Arthur Thomson asserts that this world is not a curiosity shop but a cosmos. Therein lies a guiding principle. Calling the attention of children to detached wonders of nature, as they appear in the order of the seasons, by some other plan or by no plan—no matter with what truth and appreciation this may be done—cannot do for these children what wholeness of presentation can do. We inhabitants of the earth are not something extraneous to the universe, looking at it. We are a part of it. The earth to which we are born is our unit for observation and experiment, our immediate symbol or illustration of wholeness. The earth, scientists tell us, is to be recognized as orderly, harmonious and unified. Even its seemingly chaotic disturbances are known to follow invariable natural law. In its character of unity it must be kept undivided by pedagogical claims of physical geography, social geography, elementary science and nature study, although these fields of thought all aid in making the subject clear. The earth ball must be seen in its relation to other bodies in space, and in its aspects of lithosphere, hydrosphere and atmosphere.

Moreover, to recognize the progress the earth has made in its span of cosmic history, account must be taken of its vegetation, its animal life, and its crowning factor, man. Walt Whitman says:

Gentlemen look at this wonder!
Whatever the bids of the bidders, they cannot be high
enough for it;
For it the globe lay preparing quintillians of years, without
one animal or plant;
For it the revolving cycles truly and steadily rolled.

It is the *mind* of man which exalts him above all other forms of creation. Pascal is quoted as saying, "We face the biggest fact in all science—man, with his ideas and ideals—a thinking reed, who, if the universe should crush him, would still be nobler than the universe in knowing that he was crushed." [3] The same thought is expressed for children in the lines of a poem which follow:

---

[3] J. Arthur Thomson: The Bible of Nature. Scribner, 1908.

Great, wide, beautiful, wonderful world
With the wonderful water round you curled

. . . .

Ah! you are so great, and I am so small
I hardly can think of you, world, at all.

. . . .

You are more than the earth, though you are such a dot.
You can love and think, and the earth cannot!

David, the Psalmist, wrote: "When I consider thy heavens, the work of thy fingers, the moon and stars, which thou hast ordained: what is man that thou art mindful of him? And the son of man that thou visitest him? For thou hast made him a little lower than the angels, and hast crowned him with glory and honor. Thou madest him to have dominion over the works of thy hands; thou hast put all things under his feet." This dominion man seems in these days to demonstrate literally. Geological and meteorological influences now, as in the dawning of life, play their determining part. But increasingly as his mind develops, man is becoming master of his environmental conditions. He accomplishes what he does, however, not by overcoming or ignoring law, but by learning to recognize it and working intelligently with it.

That man is one with the universe and a part of the cosmos is the theme of this book. This idea is a truth which has to be apprehended to be admitted. It cannot be taught children by the mere act of saying that it is so. But normal children of seven or eight and younger, I believe, are likely to possess a sense of it which comes to them not as knowledge, but as something which they feel and take for granted. Reference has been made to this elsewhere in this chapter.

The following lines which were read at John Burroughs' funeral service, were known to him and regarded as a statement of his own point of view: "The forest nods in fellowship. The winds my playmates are; the waters lisp the sign of brotherhood; and in the thunder's roar I hear a voice that is not wholly strange. The stars are kindly counsellors to me; I claim a kinship with the worm that crawls, and with the clay wherein the simple tale of its dim life is written." In a book entitled Cosmic Consciousness [4] the history of civilization has been searched for evidences of a human mental attainment which transcends ordinary, or self, consciousness. The author finds, in the forward march of the collective mind across the centuries, some individual minds which are in the van of the great army. These advanced minds have attained what the author terms cosmic sense. One outstanding characteristic of this sense, according to him, is the identification of the person with the universe and everything in it. Mr. Eddington says, "The physical entities are only an extract of pointer readings and beneath them is a nature continuous with our own." [5] The press reports of the 1930 meeting of the American Association for the Advancement of Science stress the same idea.[6]

Children should have concrete experiences, in universe and earth study, which can point them to underlying truths. They should gain the knowledge that can make them aware of the universe as a great, progressive, coördinated system. They should become acquainted, as far as possible at first hand, with part after part by an orderly plan; and they should understand the relation of these parts to the whole. Experience and knowledge should be provided until the realization comes through that there is order in the universe;

---

[4] R. M. Bucke: Cosmic Consciousness. E. P. Dutton & Co., 1926. pp. 53, 148.

[5] A. S. Eddington: The Nature of the Physical World. Macmillan, 1929. p. 321.

[6] Philip Kinsley: Chicago Tribune, Jan. 1, 1931.

that there is balance and interdependence; that there is continuity and sequence in events both great and small; that effect follows cause; that change and conservation go hand in hand; that apparently identical forces operate in varied fields.

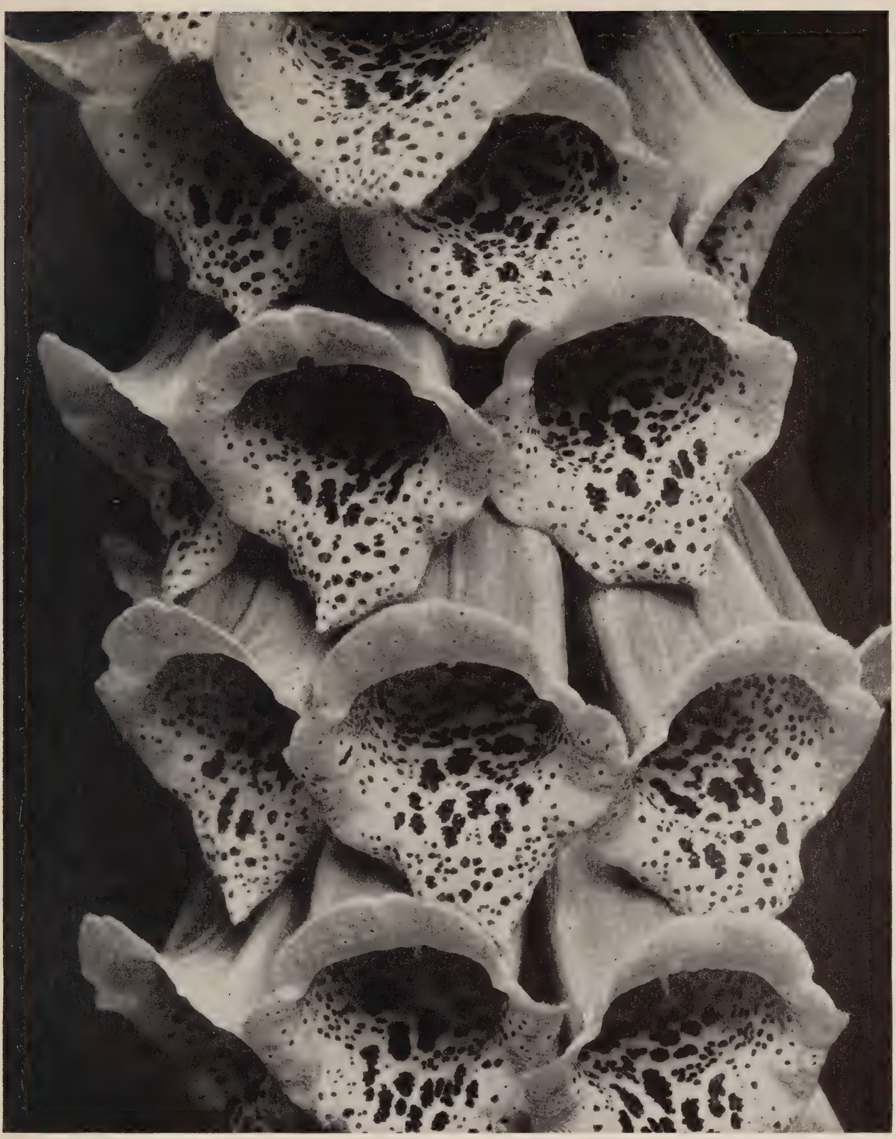
Children should begin to get hold of fundamental concepts, I believe, in early primary years. Facts of themselves may mean little. Facts in association with ideas may determine to a great extent the interests and the quality of a child's later years. In all such experience children should be made aware that, with the advance of scientific knowledge, man's concepts have from time to time had to undergo change. They should be encouraged to maintain an open, expectant attitude toward science's future achievement, and to the possibilities of unfoldment to themselves individually. They should be helped to understand, in some degree, the methods whereby science works to build its conclusions.

The wonder of the world should take hold of children, not as miracle or magic, but as rational successions of events uncovered increasingly by science, and leading thought on to the great How and Why which science never tries to answer. In the words of Mr. Thomson, the sense of wonder is one of the saving graces of life; and if it dies, he says, one of the lights of life goes out. He calls attention to what he terms mainsprings of rational wonder in the world of nature.

These, stated almost wholly in his phrasing, but summarized, are as follows: [7] *abundance of power* such as that which makes the solar system travel in space toward an unknown goal, that keeps the earth together and moving around the sun, that governs the tides and the winds, that builds a crystal, and that provides animals with energy;

---

[7] J. Arthur Thomson: The Bible of Nature.



Edward J. Steichen. Courtesy of *Modern Photography*

FOXGLOVE. ONE OF NATURE'S BOLD COLOR PATTERNS IN THE FLORAL REALM

abundance of life as illustrated by the tens of thousands of animal species; *immensities* such as the depth of the sea, the height of mountains, the expanse of the heavens; *manifoldness,* or variety, giving the impression of endless resources; *intricacy* such as the body of an ant exhibits; *pervading order* illustrated by the clockwork of the heavens, by the relations of the atomic weights of the chemical elements, the movements of the winds, or the functioning of the human body; the network of *interrelations* such as the linkages between the earthworm and the soil, the flowering plants and the higher insects, seed-carrying and birds; *universal flux* whereby, for example, water passes through the stages of rain, spring, running water, sea, mist, cloud, and again rain; *persistence and change* illustrated by the living body or by flowers; the *drama of animal life* involving struggle, family affection, mutual aid among kindred, industry, and migration; *adaptations* in the animate world, or the fitness of living creatures as regards structure and habits and interrelations; *progress,* in succession of events, which Mr. Thomson cites as the crowning wonder; and *beauty,* which he asserts is a quality of every finished and normal living thing.

How much of this thought can reach children? A considerable amount, I think, through the medium of familiar, everyday experiences. What children need to become aware of is the wonderfulness of the so-called commonplaces of the natural world about them. A leaf, a stone, a star, a butterfly, a dew-drop—each one is an open book of wonder. Walt Whitman states his belief that a leaf of grass is no less than the journey work of the stars, and that a mouse is miracle enough to stagger sextillions of infidels. Rational wonder, to use Mr. Thomson's term, with reference to the nature world, increases with knowledge and understanding. Wondering of this kind, started in childhood, should go on throughout life, widened and deepened by the experiences of succeeding years.

During a year of earth study a little boy wrote, "The mountains stand before my eyes and I could wonder everything. And I think what nature will make, as I sit and look at the pine trees and the cliff. I wonder where the most beautiful sight in the world is and the most wonderful. I would like to see it again and again. Forever I love the chains of mountains and the wonderful pine trees on the great tops of the great ridges. I love the nature and the spirit of the pine tree. Its sound fills the air with singing. The wind drives through and it makes a whole song. It makes mountain chains more real. What could be the most wonderful thing that I have ever seen?"

Nature's resources in color, design, form, structure and function are seemingly infinite. Mr. Thomson says that one natural thing would be seen to be as wonderful as another if only we knew enough about it; but he cautions against overemphasis of the emotional aspect of wonder. He points out the necessity for keeping the balance among knowing, feeling and doing. And workers with children may wisely heed this caution.

Perhaps education has no greater gift to mankind than that of putting into his childhood a wedge of this rational wonder, a glimpse of the pageant of beauty and marvelousness which nature will unfold endlessly before eyes that see and minds that receive.

He who keeps through all his days
Open eyes of wonder

Is the lord of skiey ways
And the earth thereunder.[8]

That the most thought-gripping experience in all this wonder springs from awareness not of detached instances, but of the total scheme, Mr. Thomson implies in these words: "When we consider any particular corner in the inanimate world, say the making of Niagara Falls, or the making of frost flowers on the window, we do not require in a redescription more than mechanical formulæ. But when we consider Nature not in isolated pieces but as a harmonious whole, when we recognize the progressive order, the orderly progress and the beauty of it all, then we must read back into the world egg a potentiality of giving rise to all that follows." He says also, that "even when science, as a whole, traces out for its own purposes a network of mechanism embracing all, 'no sane man has ever pretended, since science became a definite body of doctrine, that we know or even can hope to know or conceive of the possibility of knowing whence this mechanism has come, why it is there, whither it is going, and what may be beyond and beside it which our senses are incapable of appreciating. These things are not explained by science and never can be. These are things of the spirit and must be spiritually discerned.' "[9]

It is certain that no authorization is provided by science for attaching to nature any ethical qualities. Things are as they are through the logic of events. Moreover, if from some selected event an illustration of ethical behavior were drawn it would have to be conceded that some other event, equally natural in the eye of science, might present a procedure which would seem directly contrary to any recognized ethical ideal. Huxley says nature is just as much thief and murderer as philanthropist. The fact is of course that nature is none of these. It must therefore be understood clearly that science of necessity eschews all such interpretations as part of its working equipment and insistently keeps its domain free of their intrusion. A mixture of terms, such as these involve, would "keep rationality from asserting its rights." [10] Science's work is to record only what the physical senses perceive. The philosophy of science "is the philosophy of the thing perceived," [11] and does not include the perceiver.

---

[8] Wilfrid W. Gibson.

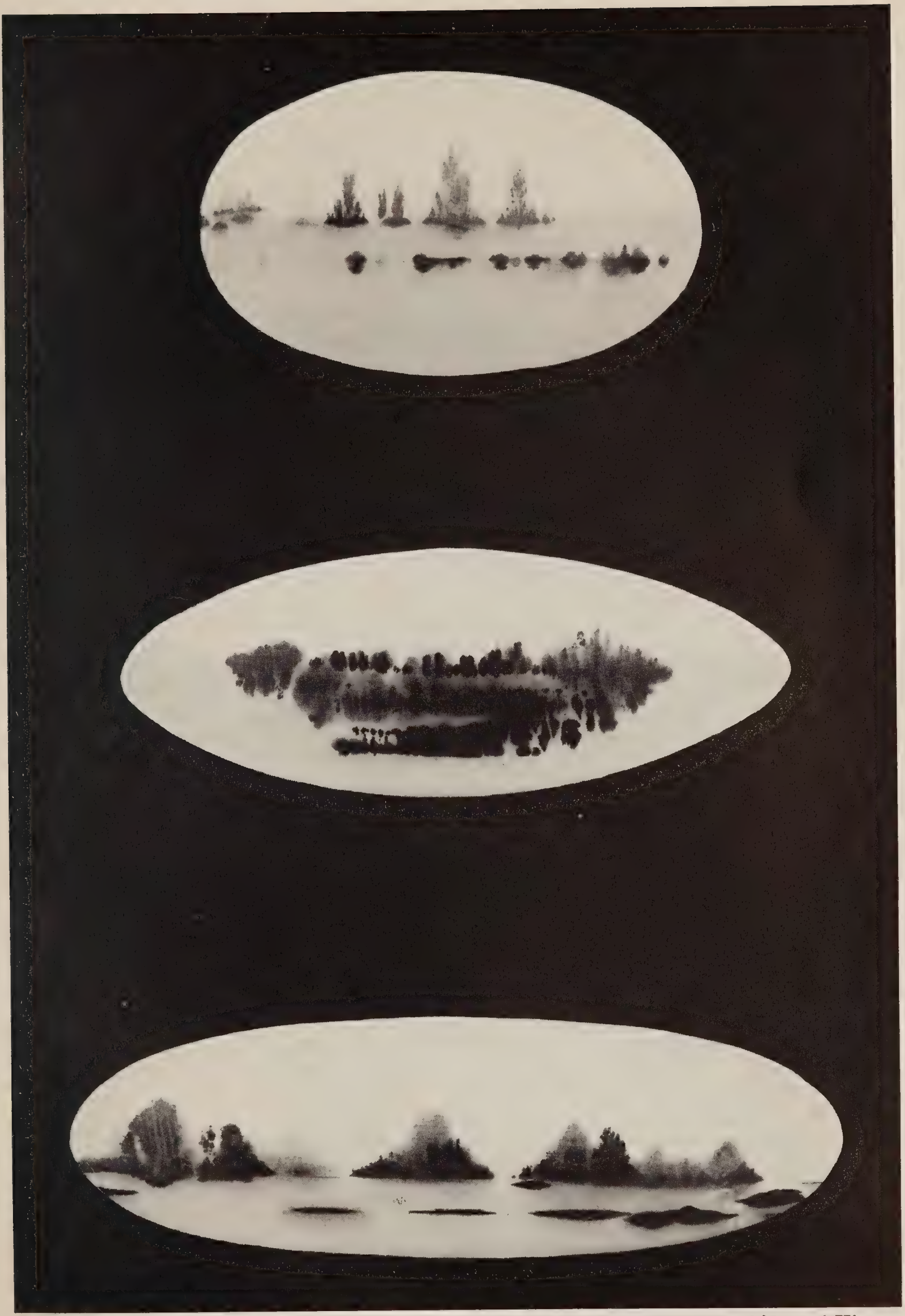
[9] J. Arthur Thomson: The Bible of Nature, p. 247.

But when the mind is able in some degree to grasp the working of a force or principle through a considerable part or all of known nature, then some thought of value to an individual, according to his own view of it, may come through. When, for example, children have read in the newspapers of a coming eclipse and have witnessed its occurrence "almost without the untruth of a single second," as Whitman said; when they have played with crystals day after day and have learned something of their structure and history; when they have spent a summer at the seashore and watched the tides go in and out as by clock-work; when, from these and other experiences, they are aware that they live in a universe in which order prevails, there is a concept in their minds which may become for them a standard. When they have played with magnets and witnessed the power of one body to act upon another, they have realized that they are in the presence of an operating law of attraction and repulsion. That the experience has significance for them, it is sure; for they are thoughtful before it. When they are accustomed

---

[10] A. N. Whitehead: Science and the Modern World. Macmillan, 1926. p. 130.

[11] A. N. Whitehead: Concept of Nature. Cambridge University Press, 1920. p. 28.



Field Museum of Natural History

AGATE LANDSCAPES, PRODUCED IN NATURE BY THE PERCOLATION OF AN IRON OR MANGANESE SOLUTION THROUGH THE FINE FISSURES OF THE AGATE

observers of nature's exquisite beauty, whether a dragonfly's wings, tiny pastel-tinted shells, spring's first little hepatica blossom growing close to a gray rock, or a cloud passing over the moon, they are likely to be finer in spirit from having had the consciousness of such experience.

When, urged by interest, they have formed the habit of observing nature keenly, their perceptions grow keener in consequence and may reach out into other fields. When they discover that knowledge of facts opens new avenues of interest, a zest for truth is the natural outcome. When they have been exposed to real ideas, such as organization, sequence, cycles of growth, and nature's exhibitions ranging from infinitesimal to infinitely great, mental expansion is bound to take place. And, as they become aware of the endless unfolding of form and beauty and organization in nature, a feeling of reverence in the presence of concrete illustration of this is likely to occur.

Out of the coming of spring, dancing sunlight, bright flowers, the song of birds, a gurgling, splashing brook, a blustering wind, or the scurrying of little woods animals, children read a message of happiness. And this, I believe, is natural, cosmic happiness. It is perhaps in manifesting this quality that children show, more than in any other way, that they and nature are one. A little girl wrote:

Spring comes skipping in!
Oh, I am so happy.
The buds come out
And children shout,
For spring comes skipping in.

Poems by other children bear such titles as Happy World, Happy Day of All Things, The Happy Poem. A group of children bound into a book the poems and other written expressions which resulted from their experiences in studying the earth. Five titles were suggested, of which the first was chosen: The Open World, Poems of the World, The World and Its Happy Children, The World Freedom, The Happy Poems, Children's Happy World. Normal children assume the happiness of every creature and the rightness of the whole world, and they live in a universe planned to be their playground. A poet referred to a certain day in which he had felt a great sense of unity with the universal harmony as "a singing day"; a little boy with the term "a leaping day" expressed the same thought. I believe that normal children experience this feeling of oneness many times daily, and that happiness is its expression; also that universe study of the right sort may have a part in fostering it.

The writer[12] of an article in The Progressive Education Magazine speaks of undesirable mental invasions which in these days are reaching children. He says, "The school has to fight against moving pictures, ninety-nine per cent of them, the Sunday supplements, the radio broadcasts, and all of the deadly encroachments upon the tastes, leisure and privacy of children. To be alone and happily employed a sufficient part of every day is essential to the growth of the soul." Children whose minds are filled with thoughts about the universe have an endless resource for playing and for occupying themselves creatively in other ways. They have an impersonal mental refuge which childhood may need somewhat, but which later years are sure to make large drafts upon. Furthermore, they can acquire, through these thoughts, a standard for evaluating. A child who has a fine and expansive inner life manifests it in the quality of the things he enjoys, and in the degree and nature of his creative expression. Almost literally free children, living apart from the city, who have discovered the universe, may carry out the dictum of the lines which follow:

---

[12] Edward Yeomans: April, 1925.

You shall not have playthings
That men have wrought for gold,
But shells and stones and sea-weeds
And nuts by squirrels sold.

Your friends shall be the tall wind,
The river and the tree;
The sun that laughs and marches;
The swallows and the sea.

And you shall run and wander,
And you shall dream and sing
Of brave things and bright things
Beyond the swallow's wing.

And you shall envy no man,
Nor hurt your heart with sighs,
For I will keep you simple
That God may make you wise! [13]

In the following chapter are set forth a plan and a method whereby children can learn about the universe. In the words of John Burroughs, "Dignity and beauty and meaning are given to our lives when we see far enough and wide enough, when we see the forces that minister to us, and the natural order of which we form a part." [14]

---

[13] Fannie Stearns Davis: The Ancient and Beautiful Things. Macmillan, 1923.

[14] John Burroughs: Accepting the Universe. Houghton Mifflin Co., 1920. p. 53.

II.

Principles and Methods

"WHO has seen the world? Neither you nor I. But we have seen pictures of it. And if we could fly to the sky we might see it really." "O world, you are full with a number of things. I do not know what all you have. Probably you have many jewels, and mines of treasures." "You have sunsets to make you beautiful. Ranges of mountains purple and gray, and the ocean turning blue and green. You have jungles where animals are free, and miles of prairies here and there."

These three quotations are from the writings of the same little girl, at the ages of seven, eight and nine, during successive stages of her experiences in studying the ball of the earth. In the first stage she was trying to regard her world as from a point in space, and perhaps to realize it as part of a greater whole; next, she was looking straight into it, thinking of what lay hidden within its bulk; and finally, standing upon the earth, she looked about her this way and that, aware of the beauty and the variety it provides in areas of water and land.

The earth in space, the inside of the earth, the earth's surface and its atmosphere may be considered subject material for two consecutive years of a primary program, two divisions of the material, in the order named, being covered in each year. The earth in space, or "star" study, is put first because it can bring about a concept of the wholeness and oneness of the earth and can affect children's thinking generally in a desirable way. Because the approach to the study of stars is largely mental, it is likely to bring out thought-evoking and thought-expanding results. The consideration of space

Lux Feininger, Berlin. Courtesy of *Modern Photography*

IT IS FUN TO FOLLOW TRACKS IN SAND THAT HUMANS AND ANIMALS HAVE MADE

gives wings to thought; it extends conception of depths, breadths, and heights. Once thought has experienced this freedom it is not likely to be cramped back into narrow quarters. It approaches the tangible now and here of familiar earthly objects with new and meaningful connotations.

Good teaching is largely good selecting. Four main subjects, to be included in a two-year plan, have been suggested here; but just what the detailed topics within these divisions should be, for a specific group of children, has to depend upon the experience and development of the children and to some extent upon their physical environment and the motivating interest of the teacher. For example, I am aware that certain basic aspects of plant and animal life which are probably suitable for children have not as yet been specially covered in any group with which I have worked. Some other person in a different situation may stress these and give less attention to other things to which I have devoted much time.

In chapters which follow each of the four subjects is discussed from the presentation standpoint. These chapters constitute a summary of work with several groups of children and represent the level of these children's attainment in the experience of one person as teacher. It should be remembered that no single group of children or individual child has passed through in detail all the experiences which they set forth, or even nearly all. Each of these chapters contains a list of topics, but it should be realized that these lists, as they now stand, were formulated after the teaching of the subject—not before. They are offered not as program but as illustration. Ready-made teaching programs lack life and spontaneity, and they cannot hope to have complete application in every or any case.

Always, the test of what to teach and what to do will have to be the evidence which the minds and attitudes of the children of the group under consideration are yielding. Variations of development are certain to be met: the important requirement upon the teacher is that the real objectives of the teaching be constantly recognized. It is true that, in large outline, this book submits a definite plan for teaching children about the universe through the medium of earth sciences and through a realization of the earth in its wholeness and in its relation to the cosmos. It insists upon certain basic concepts. It holds to the importance of a feeling approach for children based upon their actual experience. And though differences will occur in the topics chosen and in the thoroughness and the methods of presentation, there should be no differences in the outcomes of children's mental and spiritual development; no lack of appreciable progress in conveying to children ideas and concepts of the natural order that are deep enough to be fundamental and wide enough to be cosmic.

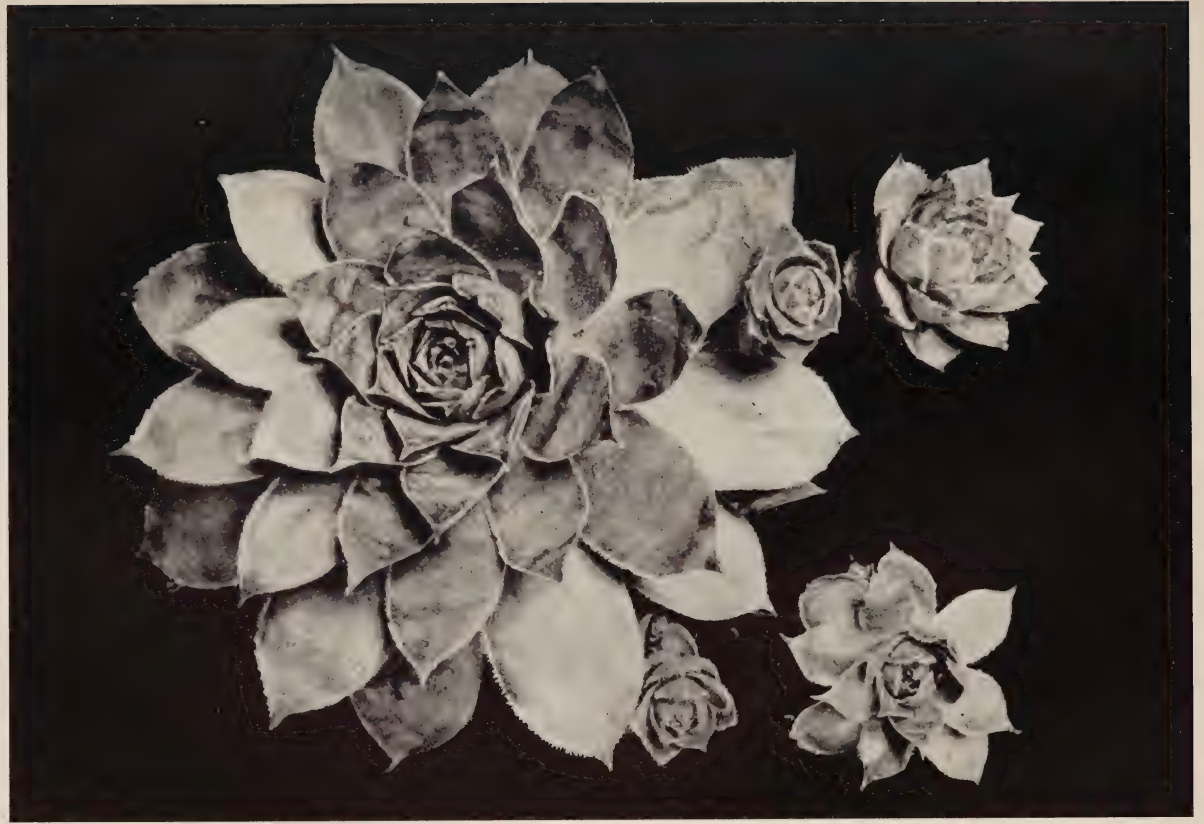
Certain guiding principles, applicable to children anywhere, may be followed in teaching. In the first place, in all this study, as already stated, values are regarded as the end and subject matter as the means. The teacher who at all times keeps real values clearly formulated in his mind as objectives is reasonably assured of meaning and permanence in his work; and he can test his results by noting the degree in which these values are reflected. Certain possible direct values have been claimed for universe study in the preceding chapter, such as awakening thought and making children aware, thoughtful, truth-seeking, expectant, responsive to beauty, reverent and resourceful. These should be, in general, the outcomes of the study as a whole. But each division of subject material can yield particular values, in ideas growing out of the special truths which these subjects unfold.

There are social values also which can come from this study. The realization of social unity has a base in the knowledge that the same manifestations of cosmic order are affecting the people of the earth everywhere, and that all these people are part of the same evolutionary development. The social joy of sharing experience, though it is not drawn from the portrayal of the natural order, is an almost inevitable concomitant of it. When children are overflowing with interest in something that is real, it is natural to communicate this interest to any available, receptive person; and people who are conscious participants in universal experience speak a common language.

Further, when children have vital interests of their own, they may assume these for other people and thus develop an attitude of expectancy in their meeting with strangers which is outgoing, friendly, and unselfconscious. Each new person can intrigue them because he is a potential representative of some different set of experiences. A game children have enjoyed is that of exchanging true, personal tales of travel and natural adventure, especially with someone whom they have not known before.

These values cannot hope to be realized, I think, unless the thought of both teacher and children is gripped by universal principles which science has brought out and is continually working upon. This is, I believe, the keynote of depth and permanence in teaching and the means of calling forth an awakened, explorative mental attitude. The generalizations or basic concepts formulated by science belong to anyone in so far as they have real meaning for him; and I believe that a child is anyone in this sense. On my conviction that fundamental concepts have meaning for children rests the whole purpose in writing this book. But the concepts should reach children in connection with concrete experience; that is, ideas along with the facts—never ahead of them. The concepts which this book stresses most are the unity and order of creation and the seemingly endless possibilities of its unfoldment.

A definite plan of procedure, learned from children, should underlie the presentation of subject material. Children are spontaneous in their approach to new experiences, I have learned, if the approach is through feeling. This first experience has normally been followed by observation and experimentation, and a demand for information which should be met. Finally comes expression, either for the sake of demonstrating clarity or to satisfy the creative impulse. In the chapters following, which deal with the presentation of subject matter, this general procedure on the part of children has been recognized. The topics dealt with, it will be seen, are not put before the children first as information. To the extent that it seems possible, children are brought into the very presence of things; and they are given time to look, to touch, and to listen. That is, their introduction to a topic is by means of actual experience or the closest possible approximation to it, that they may have direct reactions. This way of starting provides motivation for the steps which follow. It seems to be true that when little children reach the point at which they ask for facts they are able to grasp the ideas which these facts involve, even though the ideas may be of a type commonly associated with maturer years. Knowledge sought can be appropriated when perhaps knowledge imposed could not be. When a teacher finds himself in the position of trying to answer questions rather than of asking



Courtesy of *Nature Magazine*

HEN AND CHICKENS. THIS FAMILIAR ROCK GARDEN PLANT IS UNUSUALLY INTERESTING IN FORM

them, he realizes that an interesting reversal of old methods has taken place.

The principle of going slowly should be constantly observed in all this work. Children should have time to live with an idea. Progress in understanding will come not from accumulation of ideas but through their gradual unfolding. Wonder, happiness, and steady absorbed interest are legitimate factors of children's experience; but stimulation, thrills, and peaks of interest transiently occupied are not. It has been said that a teacher need not be concerned about the amount of time that is spent in sheer amusement or esthetic enjoyment when the illustration of a natural law is involved.

In my own teaching, I sometimes let children play around with something for several days, just observing and turning it over in their minds until they come to the point of wanting some information. And then I give them facts to the extent of my ability to give and theirs to receive. Visitors coming in these days of absorbing probably wonder if I ever really teach anything. But when the time for fact giving comes I welcome the opportunity to do it when no visitors are present, with nothing to disturb the children's concentration and my own.

Children will teach themselves to a great extent if allowed to be unhurried and uninterrupted when occupied with materials that are real. They need to have opportunity to play with what is before them, to try it in various combinations and under various circumstances, to show each other what they find and to coöperate in their discovering. They should explore and reach conclusions, even if they be wrong ones which have to be corrected; and their thoughts should have time to wander to appreciations and meanings which a cursory glance would not find. Mrs. Mary Everest Boole says, in reference to children's thought, "The mind should not jump to hasty conclusions. It should go through a cycle of mental attitudes, in the presence of unknown phenomena." [1] Among these she includes the following:

- Homage
- Attention
- Observation
- Analysis
- Antithesis
- Synthesis
- Contemplation
- Judgment or Classification

She says further, "Many parents seem to think that all time is wasted for their children which is not spent in taking in consciously some special idea which some adult already understands. We must get rid of this notion entirely. A child comes into science, not only to learn facts and develop the faculty for doing things, but primarily to establish relations with the laws of nature, by which we mean . . . the laws according to which the world is governed." [2] Another gain likely to result from going slowly is that of repose; and poise is its close associate. Of the former, Gratry, as quoted by Mrs. Boole, says, "In these days we need repose far more than we need work. Repose is the brother of silence. We are sterile from lack of repose far more than from lack of work." [3]

By exposing children to experiences in a free, unhurried way, one is helped to know what they are ready for. An honest lack of response in the beginning is not final evidence of actual unreadiness. An unusually large, well-formed dahlia was presented by a friend to a group not yet aware of nature's use of the rosette form. Their interest was superficial and brief, and chiefly concerned with the flower's color and size. They had seen many dahlias, before. Then several days later one of the children brought in a dandelion leaf rosette. Just a slight added degree of interest met this because of their ability to recognize, when suggested to them, a certain form similarity between it and the dahlia. Another and better dandelion rosette appeared a week or so later. This one was paraffined onto a background of buff-colored paper. The design stood out arrestingly. A rosette-finding walk followed.

---

[1] Preparation of the Child for Science. Oxford University Press, 1904. p. 16.
[2] Same, p. 47.
[3] Same, p. 48.

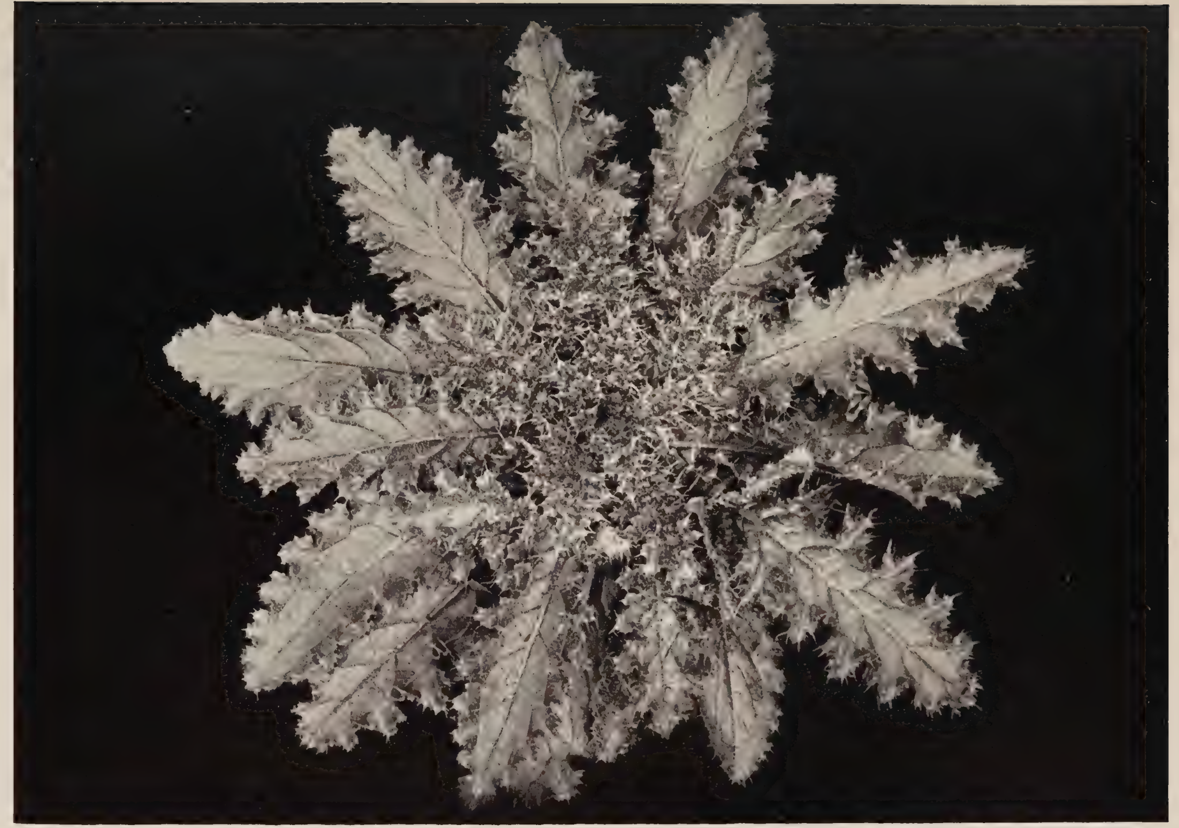
From that time on, interest in rosettes grew and grew until all the common weed forms of the neighborhood and many other types of rosettes were known to the children. The classroom was made wonderful with huge thistle, mullein and other leaf rosettes paraffined to promote their preservation and display. Then came original rosette designs, both large and small, drawn and painted by the children. In the course of this experience a study was made of nature's reasons for adopting the rosette form. Nature's rosettes will, I believe, be real in the consciousness of this group as long as they live.

On the other hand, if with a reasonable amount of exposure to an idea or fact children do not grasp or go out to it easily and naturally, one should not be anxious, but just let it go. There is a right time and a right place for every needed thing. None of this experience or knowledge has to be struggled for in childhood. The object is not accumulation of facts; it is the growth of the spirit, the awakening and unfolding of thought. Cramming upon a mind what it is not ready for, is not helping to awaken that mind or to lead it joyously on in development; it may even result in shocking, stultifying, confusing, or closing it.

One of the first requisites in teaching is that the teacher's own mind shall be clear in the field in which he is working.

He cannot hope to act intelligently with regard to something which he has not mastered or appropriated himself. Neither can he, under such circumstances, be a judge of children's capacity regarding it. But if his own thinking is clear and correct on a given topic, and if he has tried without apparent success to bring out understanding in a clear, simple, unhurried, child-like way, there is probably nothing further to be done. If the children do not get it, under such favorable conditions, they are probably not ready for it. But it will generally be true that if a teacher has done his part and if he has a reasonable amount of intuition, such an impasse will not be reached. For the most part, the children's questions and the logical unfolding of the subject will point the way to him wisely. He will realize before he gets to a situation of this kind what the group can assimilate and enjoy.

A matter of importance is the attitude of the children towards what they are learning. If they have an eagerness for knowledge which is in any degree self-conscious intellectuality or a desire to feed self-importance, the work being done is on the wrong track. More harm than good is resulting; and a great opportunity is being lost. If they have any sense of finality, in that they suppose the bit of knowledge they have acquired is all there is to know, the result obtained is the exact opposite of what it should be. The experience of universe study should establish a sense of proportion; it should give intriguing glimpses of what lies beyond; each step of advance should point the way to another; and the possibilities of endless and wonderful unfoldment should take a strong grip on consciousness. Children should have enough information of the methods whereby scientific knowledge is acquired to make them actively interested in



L. W. Brownell

THE THISTLE LEAF ROSETTE, FOUND IN FALL IN ALMOST ANY FIELD

keeping in touch with the findings and revisions that take place from year to year.

Nothing is more important than that children should live in the present. The fact that one is working with a general subject outline need not, and should not, be a reason for neglecting the natural experiences that come day by day with living. All will in time find their places in the logical plan. Each season is to be enjoyed for the special round of interests and pleasures it brings. At all times children should be getting acquainted with the immediate region of the world which they occupy. One should let them explore their own neighborhood thoroughly, and be glad if they acquire haunts which they return to again and again. In this way, too, they find friends among people and animals, and visits and revisits may occur. They have opportunity to know, by their own discovery, where there is a rhythmically beautiful tree, a spot where a heavy rainfall makes little rivers that wear away the earth, a rendezvous of spiralling pigeons, a wall made of interesting stones, or some person who knows and loves some special field of nature.

Children should, if possible, know their world in the aspect of night as well as day. They should have opportunity to see the moon-made shadow designs on house or ground, to feel the quietness of night, and to look for a long time if they wish at the moon and the stars. Let them, sometime, walk in the woods at night playing a flashlight this way and that as they go; and let them stand still and listen. Let them take a lantern out into the garden to see what the plants are doing.

In daytime let them play in the wind, and in a snowstorm, and even in a glorious rain. Let them climb trees, and jounce on branches, provided the branches are strong enough for safety and to prevent injury to the trees. Let them swing on wild grapevines, scramble over rocks, slide down hillsides and jump over brooks. Let them go barefoot, in season, or wear soft-soled shoes. Let them walk, and run, and wade, and skate, and swim. Enjoy with them the spirit of adventure. Follow a path wherever it leads, or the course of a running stream; and chase a tumble-weed wherever it blows. Let them find in nature an intriguing coöperator with their sense of humor and fun.

If children live in a city, a park should be made to yield all it can; and a way should be found for unhurried trips to the country, at least two or three times in each season. Wherever they live, they can be encouraged in making discoveries on the way to and from school. Three little children going home along a city street saw big and little bird tracks in some mud, probably pigeons' and sparrows'. They saw a leaf form beautifully stamped, by a fallen leaf, upon the concrete pavement. They saw a pile of building stone which to them seemed like a castle. And they watched the sky pictures to be seen at every street end.

It is a necessary principle that little children should be taught the truth about the universe as scientists describe it. But this does not mean specimen hunting, identifying, classifying, labeling, and the making of collections and museums. Those activities belong to an "age of precision" in science which the years seven, eight and nine have not reached. These early years, however, are not to be considered a period of limitation because they are not the years for grasping scientific knowledge in classified form. Rather, they should be thought of as, in some ways, the most wonderful years ever offered to education's purposes. At this period children's minds, as pointed out in the preceding chapter, are wide open; their attitude is fresh and expectant. They have not yet entertained the concept of being too old to respond naturally, or of being in too great a hurry to follow an interest through or to ponder an idea. These are years of wonder and romance; of simple receptivity to beauty and to illustration of universal truth and spiritual meaning. Children, in these years, are consciously close to the collective principle, or source, or whatever stands for the primal cause of all effects.

It is no reflection upon the status of a child's mentality, but a reason for glorifying it, if a flower for itself arrests him. After all, the consummate wonderfulness of the flower is its immediate life and beauty in its immediate natural setting. The present unified fact before his eyes is of more value to him than the knowledge of the names of this flower's kindred, or of its divisions and subdivisions. It means more to the child, at this period, that he shall *realize* a flower than that he should seek to catalog it, mentally or actually, as one of a kind. It means more to him to be aware of it as a whole than as an assemblage of parts. Whitman must have been of this mind when he wrote:

Have you reckoned the landscape took substance and form
 that it might be painted in a picture?

Or men and women that they might be written of, and songs
 sung?

Or the attraction of gravity, and the great laws and harmonious combinations, and the fluids of the air, as subjects
 for the Savans?

Or the brown land and the blue sea for maps and charts?

Or the stars to be put in constellations and named fancy names?

Or that the growth of seeds is for agricultural tables, or agriculture itself?

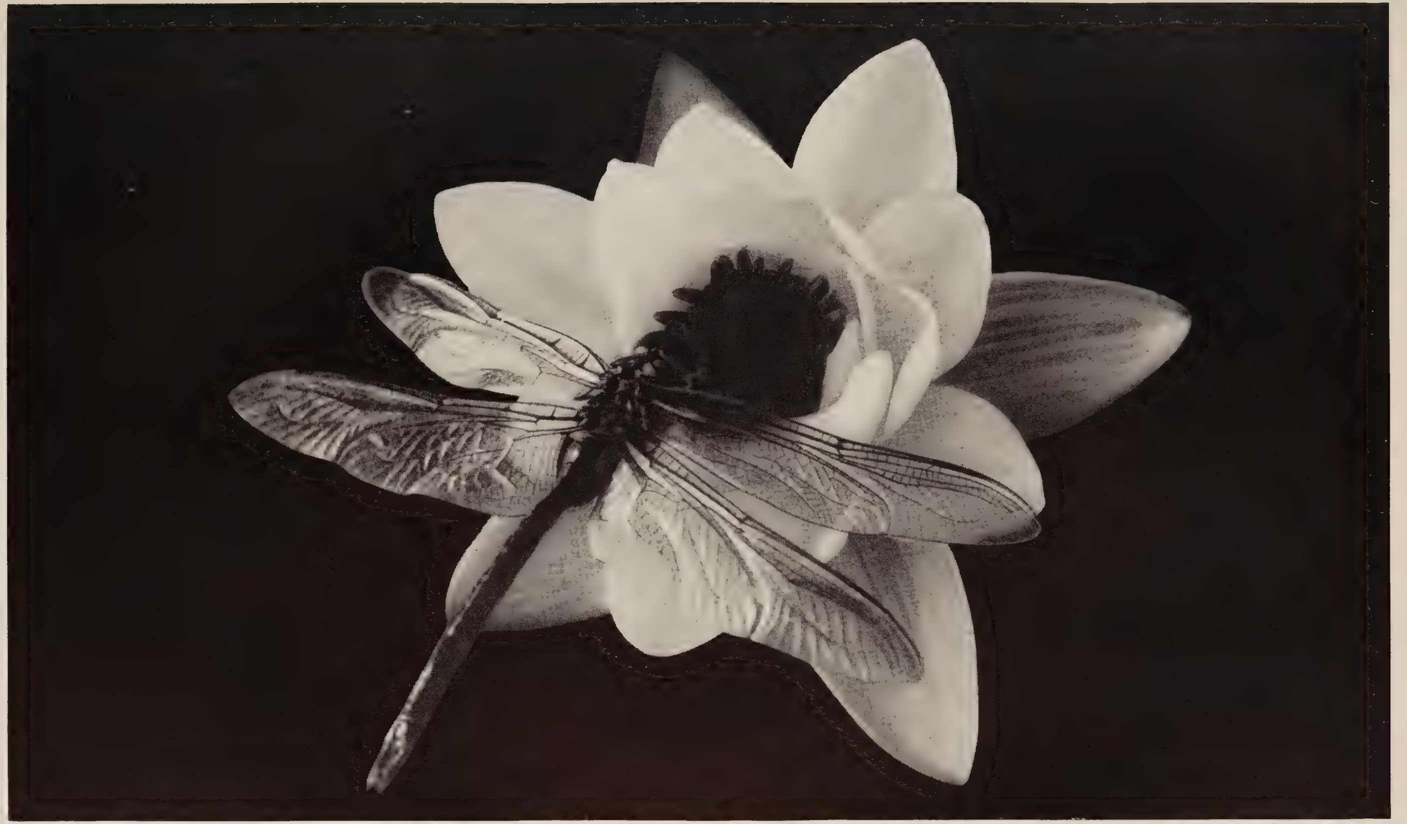
Children can indeed perceive the working of law through concrete manifestations of nature; and perception sufficient for their years can come to them without the intensive, analytical method of laboratory research. Magnetic attraction, plant growth, and the mathematical precision of certain natural events and forms are illustrations of what comes easily into childhood experience and brings with it basic thought value.

A guiding principle in teaching, generally, is to be found in children's mental liking for events told in sequence. Thus it is they enjoy stories such as The House That Jack Built, The Pig Who Would Not Go Over the Stile, and The King's Breakfast. And in this matter nature is a reliable coöperator, for the universe abounds in sequences. They are but chapters in one great continued story of evolutionary growth; and they reveal some of nature's most significant truth. "The rain falls, the springs are fed; the streams are filled and flow to the sea; the mist rises from the deep and the clouds are formed, which break again on the mountain side." [4] Such cycles of sequential events are occurring in the realm of space and in the earth's crust; in the production of butterflies and flowers; anywhere one looks for them they may be found. Throughout the chapters which follow it will be observed that this cyclic concept of nature has been regarded as outstanding in importance.

Of course children should learn through direct experi-

---

[4] J. Arthur Thomson: The Bible of Nature, p. 17.



Lynwood M. Chace

THE DRAGON-FLY HAS WINGS OF EXQUISITE DELICACY

ence so far as possible. But there are many things they need to know which cannot come to them at first hand, literally and tangibly. It is a manifestation of normal intelligence that things seen, or experienced in some other way, should suggest things which in the immediate environment cannot be seen or otherwise experienced directly; and present experience may depend for its explanation upon knowledge of the non-present. It is reasonable and right to supply the information prepared for in both these ways. The important factor is that children shall make a clear distinction between what comes to them by their own experience and what comes by description.

Simple scientific tools or playthings, such as a magnet, compass, sun-dial, sun-watch, top, ball, gyroscope, boomerang, pendulum, kite, lens, prism, magnifier, camera, an artoscope, and a blue-print outfit, are useful aids to first-hand knowledge. Some of these, it will be seen, are used to show the working of what are termed physical laws; others aid seeing, either by making an object clearer to the vision or by recording what the naked eye can see. Each of these tools, or playthings, has unlimited possibilities for adventurous, creative, instructive pleasure; therefore, in using them, care should be taken not to crowd experience upon children. Introducing them gradually, as they find relationship to the subject which is being considered, is the only method which insures the discovery of their possibilities, keeps children from over-stimulation, and allows time for children to share their discoveries with each other.

Books, pictures, lectures, the accounts of friends who have had the experience in question, and dramatic play and other modes of illustration, are all needed in the acquirement of knowledge at second hand. There is in the field of children's books today a considerable amount of material dealing with natural science in a roundabout story-telling way calculated to win interest. Although some of these books are attractively and carefully prepared, it may be found best to avoid them, for teaching purposes. They can perhaps serve children who have no other informational approach to the subjects referred to. In teaching, the plain, direct statements of simple science texts have the greater power to grip a child's thought, to cause him to trust the truth of what is stated and to give his own imagination free play. Scientific truth needs no embellishment to make it interesting.

Poetry that is universal in its character, and other forms of literature, can add much that is valuable to earth study if the examples chosen represent facts truthfully, and tend to bring out and make active the reader's own thought. These criteria rule out the products of the swarm of nature poets who record personal reactions which give no evidence of knowledge or real understanding; also the empty versification which appears in volume upon volume of publications for children. Because they state natural facts accurately and simply and have power to awaken real ideas and independent appreciations, I have made large use of Japanese Hokku poetry[5] and of the writings of Walt Whitman. In repeated instances Whitman shows his response to the operation of nature as a whole as well as to its lesser manifestations.

Shelley is another truth-writing poet. Writers in the field of science have agreed in saying that he holds up a mirror to things as they are. Mr. Whitehead says if Shelley had been born a hundred years later the present century would have seen a Newton among chemists; that the absorption of his mind in scientific ideas can be seen in lyric after lyric.[6] In Prometheus Unbound, Mr. Whitehead points out, he makes the earth and moon converse together in the language of accurate science; and physical experiments guide his imagery. I have used Shelley's poetry with children whenever I have found lines which I think they can understand.

---

[5] The Japanese Hokku poems quoted in this book are taken from Japanese Poetry by Basil Hall Chamberlin, Japanese Poetry by Curtis Hidden Page, and Little Pictures of Japan in The Book-house for Children.

The Homeric poems might be thought of as based upon ideas about the universe; but they are fanciful ideas not backed by knowledge. Because of this lack of literal truth and because they may feed imagination more than they beget it, their value in work with children is qualified. I have used selections from these poems, but only at a somewhat advanced stage of teaching experience with a group. One would not have children miss altogether the concept of the splendors of the sun which Greek mythology depicts; or the dashing steeds which course the stars and the chariots which roll on clouds through space, the ocean heaping up mighty waves and tossing spray to high heaven, the raging winds and gentle zephyrs. One would not have them miss, either, the concept of reeds and rushes murmuring and whispering their secrets, or charming details of ways strewn with flowers, of victors' wreaths, maidens' garlands and festal processions.

It seems only natural that poetry, provided it be of the right sort, should be used in helping children to realize the universe, and that they should find poetry a vehicle of expression for their own responses and observations. The quality of poetry may shine through the scientist's baldest statement of scientific truth. Science's straight, unadorned story of the moisture cycle, of the movements of bodies in space, of the pageantry of plant growth and of the seasons, can scarcely escape the charge of being poetic. The poetic aspect of these things can get into minds that have accorded no attention to the concrete form of a poem. Almost anyone may find the poetry in his nature aroused by reading the annual proceedings of the American Association for the Advancement of Science. An elucidator of Einstein writes, "Einstein's theory has the highest degree of esthetic merit. Every lover of the beautiful must wish it to be true." [7] It has been said:

---

[6] A. N. Whitehead: Science and the Modern World. p. 119.

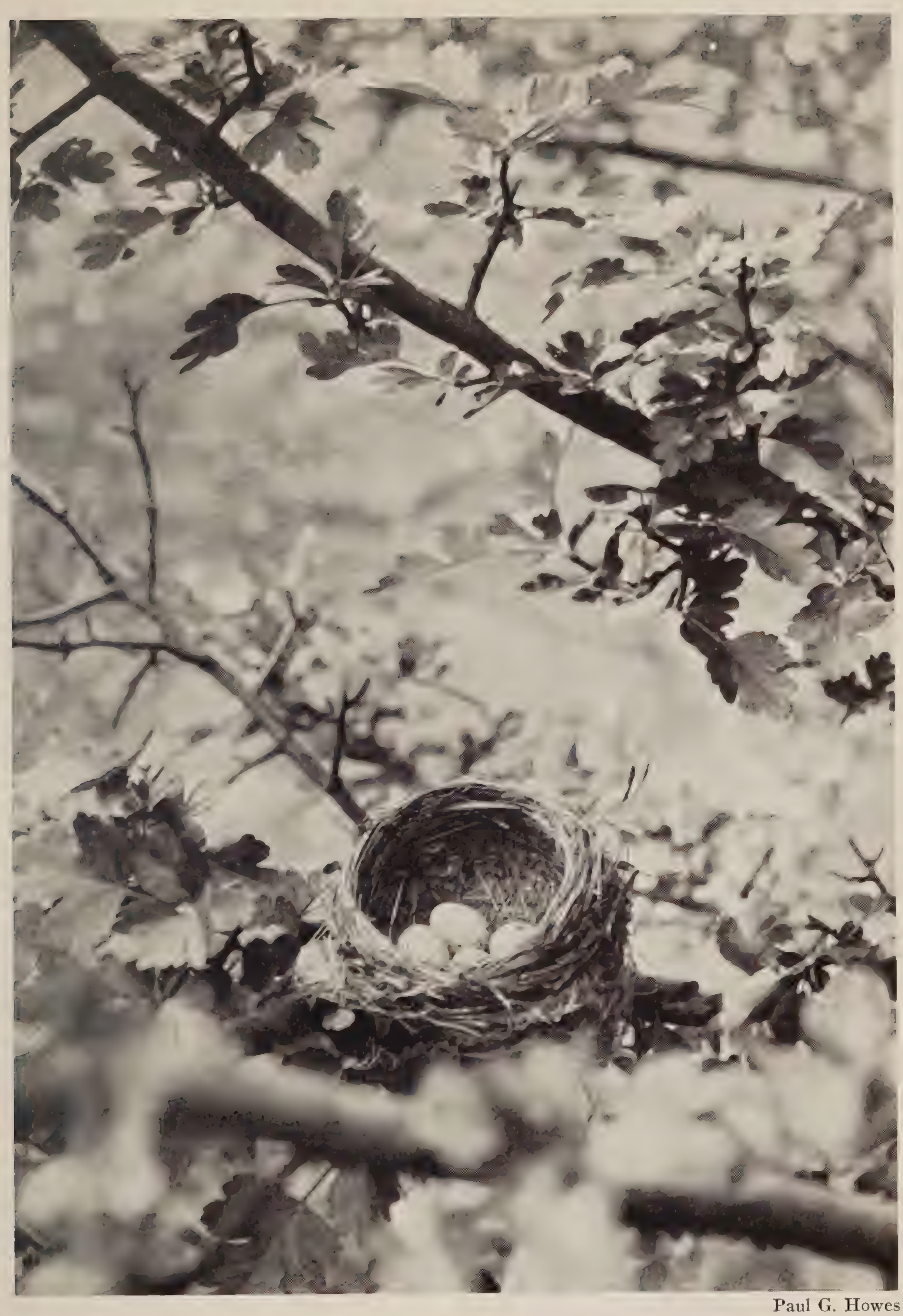
God on his throne
Is eldest of poets.
Unto his measures
Moveth the whole.

Children's dramatic representations of universal facts and events, especially when these find expression through the children's pantomimic rhythmic movements, almost unfailingly bring to the onlooker a poetic note at least; and they sometime seem to be almost wholly poetic.

A contemporary writer [8] holds that poetic quality, to be that, includes something traditional as a necessary factor. If by traditional something universal can be meant, that definition is recognized here. Poetry, the expression of poetic quality through the medium of words, it will perhaps be conceded, involves among other things impressions keenly felt, imagination, the music of words, the rhythm of metrical form; and it may involve suggestions of beauty. Simile finds large application in poetry because, as pointed out elsewhere, it is born of appreciation of the essential qualities of things. Simile involves both appreciation and the further step of comparison.

---

[7] Hendrik Antoon Lorentz: The Einstein Theory. Brentano's, 1920. p. 23.
[8] John C. Powys: The Meaning of Culture. W. W. Norton & Co., 1929.



Paul G. Howes

SKILLFUL CRAFTSMANSHIP IS SUGGESTED BY THE NEST OF THE YELLOW WARBLER

In the education of children the experience of hearing or reading real poetry is both end and means, as I see it. We want poetry for what it is and for what it does. This does not mean that we want to make children readers of poetry in any special degree, or that we want to make professional or even avocational poets of them. But if the poetic consciousness has been awakened in children, it is likely to be developed by hearing or reading poetry of the right sort; and it will probably develop itself further by finding some sort of poetic expression, whether in words, in pantomimic dramatization, or in graphic or plastic arts. Poetry is the language of the spirit, as the psalms of David show; and we should not be surprised therefore to find it the language of children. Rhyme and meter have been in the past, I believe, great obstacles to any verbal expression on the part of children which could claim poetic value. When these factors have been considered first essentials of poetic expression, the result is likely to rest on mechanics more than on meaning.

Some of the best poetic expression of children, in my experience, is that which was written just as expression, without conscious thought of its poetic idea or form. I have sometimes recorded verbatim, as poetry, casual statements made by children who did not think of them even as expression. There seems to be, for example, a haunting beauty in this merely news-giving remark of a little boy, just home from an outing in Maine:

> Up in the woods you heard a wild bird singing
> Across the pasture, up the hill.
> It was a long woods, but a short way through.

In a written record of a woods experience another boy, so far as I know unconsciously, lays hold of music and rhythmic, if not metrical, form as well as poetic thought: "Trees are swaying, birds are singing, tadpoles are in the brook. Squirrels jump from tree to tree, and seeds are dropping for fall. I go up on a rock and look far away, and I see a bird's nest up in a tree." I think a teacher has a part to play in recognizing and salvaging the poetic expression of children, being careful to avoid, however, any procedure that might tend to make them self-conscious. The by-products of improved diction and voice quality, and poise, have sometimes resulted when children read aloud real poetry which they understand and enjoy.

It is true that metrical quality and music of words, in poetry, make a strong appeal to children. They arouse rhythmic response, which is one of the deepest human experiences. But just because of this, poetry which derives its character wholly or chiefly from meter and music should be considered in a discussion of rhythm, rather than a discussion of poetic consciousness. Anyone who is accustomed to reading aloud to children may have discovered that they will respond to rhythmic sound, quite apart from its sense. Probably a poem in an unknown tongue, if rhythmic enough, could become for children a choice possession.

The poem of Eugene Field about the Dinky Bird who goes singing in the amfalula tree is surely loved most for its rhythm and its invented musical words, although it is true it has other qualities which count with children. Those who have seen the swing of a scythe and heard its recurrent swish as it mows its path through the grass will not fail to find rhythmic pleasure in the "Song of the Scythe" by Andrew Lang, of which the first lines are these:

Hush, ah hush, the scythes are saying,
Hush, and be still and fall asleep;

Little children may only partly understand the meaning of Mrs. Browning's poem which begins, "What was he doing, the great god Pan, Down in the reeds by the river?" but they will listen to all of it because they enjoy its rhythm.

One of the most satisfactory aids to teaching is the stereograph, produced now in a wide range of nature subjects. A few well-chosen pictures, related to the subject at hand and lived with, are useful to a degree which many pictures on many topics, cursorily looked at, could not be. The stereograph makes real and present what, without its help, might be only dimly imagined. Even familiar sights may be inaccessible ones, and the stereograph can aid with these also. For example, children may often have had glimpses of redwings or bluebirds in flight or briefly poised; or, by climbing to a precarious viewpoint, they may have looked for an instant into a nest of bird's eggs. But the stereograph brings them close to these things in natural surroundings and lets them stay there as long as they like.

The post-card projector and the lantern are helpful also. Children can operate these themselves, and also make slides for them. Now and again some moving picture rarely successful from the teaching standpoint appears on the screen. Several years ago a film was produced showing in accelerated movement the natural rhythmic opening of flowers, and it is still being shown.[8a] It is an experience of beauty and information which witnesses seem unable to forget. Moving under-sea pictures and pictures of animal life in natural surroundings can be of value also, when they are photographed from nature. Beebe's films and some of German production are outstanding in these fields.

[8a] Arthur C. Pillsbury, Berkeley, Cal. Photographer and lecturer.

It is a question whether, for teaching purposes, pictures obtained from the domain of art should, as a rule, be used. When one employs these he is likely to be teaching not directly but through the medium of interpretation. Certain paintings or drawings, however, do seem to serve the purpose of calling attention to the working of some natural principle, or they seem able to expand the independent thought of the beholder. Supplementary to the aids which the teacher enlists are those which the children bring in voluntarily. All sorts of interesting little finds, treasures lent from home, pictures hunted up in books and magazines, newspaper clippings, and many other contributions are among them. The older members of a child's family are likely to add their cooperation.

Familiar, available material may sometimes serve to illustrate what is not familiar. For example, a tiny brook or a roadside waterflow can actually present some of the physical features of a river to children who cannot see one. Also, material at hand aided by imaginative, dramatic play may get certain facts realized apart from any factor of actuality. For a group of children studying about the earth's surface, a rough tract of ice in a snow-covered field on a day of white fog was an opportunity for North Pole exploration, the loss of bearings and the need for a compass. The tunnelings of a subway and cellar beneath the school buildings, with unexpected dark recesses and drippings of water, became the Mammoth Cave. There they heard make-believe echoes and amplifications of sound, and saw make-believe stalactic or stalagmitic formations. The discovery of a huge straw pile, just when they were engrossed in the ways of woods animals underground, gave opportunity for intricate burrowings and humorous scamperings and scurryings out of sight. A sweep of partly level, nearly treeless land several acres in extent, became for them the Great Western Plains, and there they held a rodeo and a round-up.

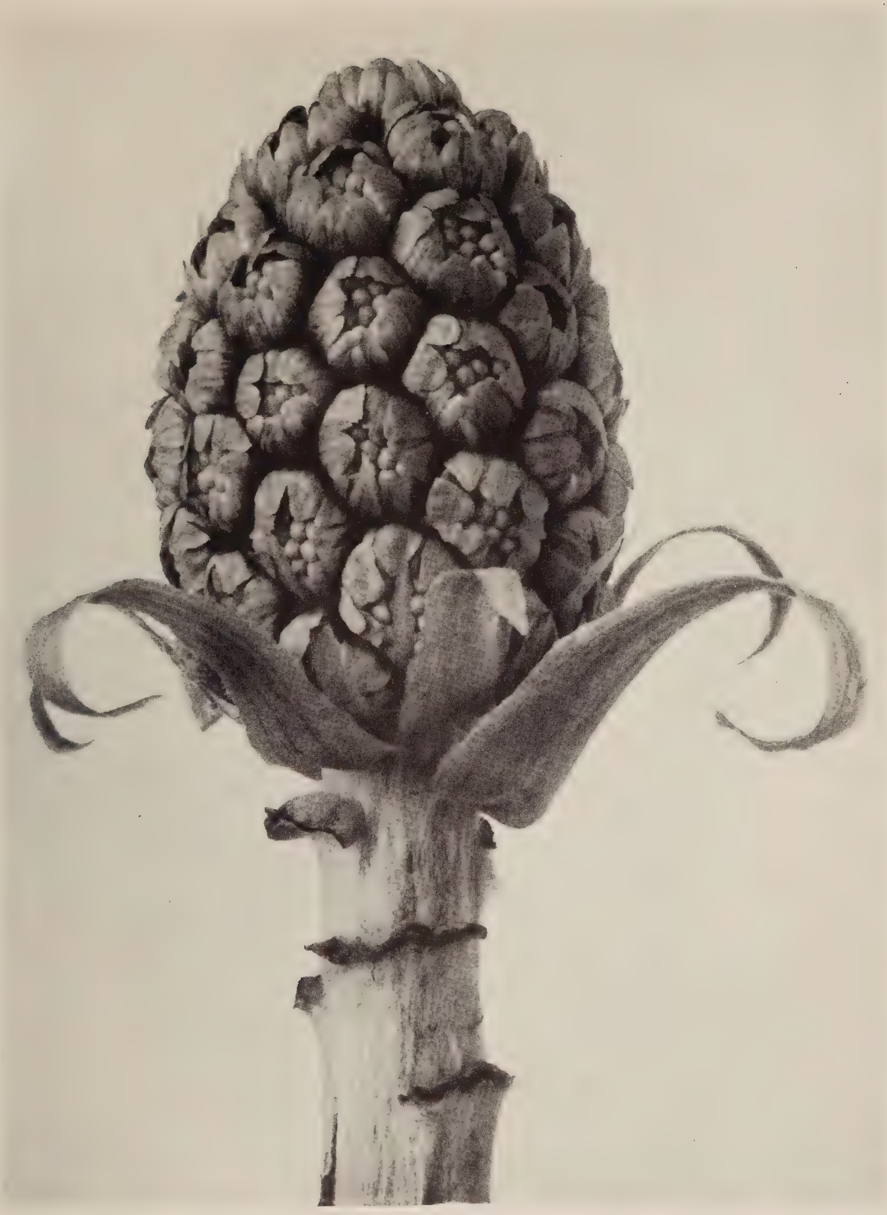
In order to have some check upon the correctness and clearness of the impressions children are gaining, regarding facts, the teacher can have them dictate or write from time to time exact statements of information or experiences. This is entirely apart from the creative writing which children are likely to produce as a result of an awakened mental state. The formulation of exact statements helps to make the necessary distinctions between observed and described information, between actual occurrences, and conjectured or imagined ones. When the primary object is final clarity concerning some topic, probably nothing can take the place of verbal statement, dictated or written. But written expression is a slow, laborious process for children who are in the learning stage of reading and writing; and on less exacting occasions it need not be employed. When the purpose is not more than to make some tentative graphic representation of ideas received, drawing provides a medium more satisfactory, independent, and easily available.

Through drawing of this kind, not to be confused with the free creative drawing for which opportunity is given also, the teacher can check on the effectiveness of the factual teaching. He can be helped to know, by its means, what ideas the children are being left with. The clearest of such drawings, gathered together in a book in an order which represents logical unfolding, provide a permanent means for keeping information and impressions clear, connected and current. This book, in other words, constitutes a device for unconscious review of subject matter and accustoms children's thought to the orderly sequence of the ideas it includes. It is important that this should be a beautiful book, fine in the character of its drawings and the quality of its paper, and carefully treasured.

The questions which children ask are a further aid to establishing clarity. A direct question should be met directly if possible. However, clearness in general will not be served thus if the questions of one or two especially keen-minded children of a group run beyond the general level of understanding. The consideration of such questions, in the presence of the group, would be likely to interfere with an orderly, logical unfolding of ideas at a pace suitable for the majority. In such cases it is best to deal individually with the persons who ask the questions.

Teaching, by the children themselves, which affords opportunity for them to exercise initiative in organizing and presenting ideas, can be useful in fixing and summarizing subject material or procedures which they have previously considered. Children of eight years are well able to choose their teaching subject, to plan its orderly presentation, and to provide means for illustrating it. If two or three children are appointed to teach jointly, there is even greater opportunity for initiative in intelligent organization. And incidentally, with pupil teaching, poise may be developed both in the child teachers and those who are taught; and opportunity is given to accord careful regard to neatness, effectiveness and beauty in the arrangement of materials shown—a matter which the teacher in his own procedure should not overlook. The teacher's standards in such ways are certainly reflected by the children.

School assembly programs, given occasionally after a field



Professor Karl Blossfeldt. In Urformen der Kunst,
Ernst Wasmuth A. G. Berlin

BOG RHUBARB. GLOME, ENLARGED

of thought has been lived in and become a part of the children's mental life, are another means of summarizing ideas; and they can help children to make their acquisition of ideas articulate to others who have not been following the same chain of experiences. Responsive visitors to the schoolroom provide the same opportunity. It is worth while at times to let children invite guests for the specific purpose of sharing intelligently, entertainingly and unselfconsciously a set of experiences which the children have passed through.

If a curriculum accords to universe study the importance which this book claims for it, it will allow it to be placed first in the day's program. If this study is taking hold of their thought, children will come to school in the morning with ideas, experiences, or illustrative material relating to it, which they want to share. This impulse on their part should have opportunity for satisfactory recognition; and it can have if the opening period concerns the same interests. Moreover children bring into the beginning of each new day a freshness and spontaneity which should be capitalized for the purposes which universe study seeks to bring out.

Following the period of discussion each day I have been accustomed to give children opportunity as a rule to express themselves through drawing, writing, dramatization or in other ways. This expression is sometimes literal and sometimes creative. A period of an hour and a half, sometimes extended, has included both discussion and expression. Additional time for creative expression has been found during the week; also for out-of-door experiences. Creative expression is a natural outcome of vital learning; and children should have time and the necessary space and materials to play with their ideas, dramatize them, dance them, draw them, paint them, dye them, model them, build them, write them, and express them through the medium of music.

Little plays and rhythmic pantomimes lend themselves with apitude to the expression of universe ideas. Poetic dramatization of the universe, in which the imagination is free to do what it likes, seems to me not only to be permissible and natural but to have definite value in beauty. The important aspect of it from the teaching standpoint is that when children work imaginatively it should be perfectly clear in their minds that they are doing so. One need not fear giving children free rein in the field of imagination if they realize that they are in that field. Children can be brought into the understanding that there are two distinct ways of dealing with material dramatically: that one way has to do with the illustration of impersonal facts with the view to getting them comprehended correctly, the other with the imaginative expression which these facts may suggest to some individual or group.

What is essential in the equipment of one who is to help children to a concept of their world and their relation to it? The desire to do it, primarily. Any intelligent, thoughtful, truth-loving and nature-loving person who has read and appropriated Thomson's Bible of Nature, and who has familiarized himself in a general way with the knowledge contained in such books as A Beginner's Star Book,[9] The Earth and Its Rhythms,[10] The World's Minerals,[11] Handbook of Nature Study,[12] and Fogs and Clouds,[13] or their equivalents in content and reliability, is prepared to start, from the standpoint of the plan here outlined. It is assumed of course that this person has the individual qualities necessary to any good teacher in work with primary children, and that he has access to ordinary library resources. Day by day, as he adventures forward with the children, knowledge and experience can be added to meet the day's need. Not literally, however. The teacher will see his way ahead, in a general sense, for several weeks at a time and prepare himself accordingly.

---

[9] Kelvin McKready. G. P. Putnam's Sons, 1923.
[10] Schuchert and Le Vene. D. Appleton & Co., 1927.
[11] L. J. Spencer. Frederick A. Stokes Co., 1916.
[12] Anna B. Comstock. Comstock Pub. Co., 1919.
[13] W. J. Humphrey. Williams & Wilkins, 1926.

Many specific page references to the suggested books and to a few other books have been provided in following chapters dealing with subject matter presentation. Current published information on natural science subjects is abundant. Keeping to the general plan of teaching the earth as a whole, and in its relation to the cosmos, this information can be drawn upon according to the need. Sometime the teacher may find it possible to take some intensive work in some field of science study, or to have a course of training in fundamental rhythmic movement. These are suggestions for persons whose preparation has not already provided them with the background they need. No quarter is given to the idea that a primary teacher, because he deals with little children, does not need to make careful, intelligent provision for bringing real content into every school day.

There is another factor, difficult to classify, which should be recognized in teaching. It seems to belong alike to the experience of the children and to the qualities demonstrated by the teacher. It has a relation to an individual's feeling of oneness with the universe[14] and can be designated by no other term than love—in the universal rather than the personal and emotional sense. Without this factor the concept of the universe is empty, mechanical, unillumined. Some realization of it comes to children naturally and unanalytically, I believe. They can prove unconsciously and without thought of an undercurrent of meaning the words of a children's song:

---

[14] See R. M. Bucke: Cosmic Consciousness, p. 73.

There is beauty in the forest
When the trees are green and fair,
There is beauty in the meadow
When wild flowers scent the air.
There is beauty in the sunlight
And the soft blue beams above,
Oh, the world is full of beauty
When the heart is full of love.

III.

The Earth in Space

A STUDY of the earth in space is a study of the heavens. So spontaneously does a group of seven- or eight-year-old children respond to a first talk about stars, that there is no room left to doubt that their thought is ready for it and seeking opportunity for expression and greater understanding. It seems to be generally true that such adult coöperation as they have had has been in the nature of recognizing dipper, chair or sword-belt; and that the children's own thinking has been concerned largely with theories of what the stars are, and the possibility of reaching them.

"I used to think," a little girl said recalling the age of seven, "if you went up toward the stars their lights would get wee-er and wee-er." Another said, "I thought the stars were tiny round balls in the sky like lamps. I thought if people would hang ropes on the sky they could go up and see the stars. I made believe the clouds were blankets but I really thought that smoke went up and made them. I thought air was really colored blue. I made believe that a man went up in an airplane to light the sun."

When children begin to invent explanations of the universe, the time has come to help them with some facts as described by science. For a child, or anyone, universal truth adds and multiplies pleasures; it does not lessen them. Star thoughts, as already pointed out, are expansive; they at once jog children's minds out of ruts and they easily set going the wonder and expectancy that never need end. For this reason alone, one might, in a series of earth studies, put first the study of the earth in space. But, as the preceding chapter states this is also the logical order; for, to have a concept of the earth as a unit, it becomes necessary to apprehend it as a body in space.

Children who are in the first stage of wondering about stars know the experience of silent thoughtfulness. They are prepared to appreciate such a painting as W. L. Taylor's, When I Consider Thy Heavens.[1] This picture in colored reproduction seems to be unfailing in its power to hold attention. Children look at it for a long time, evidently led by it to think their own thoughts. From their expressions in regard to it, it is apparent that, mentally, they are themselves standing in the shepherd's place on the rocky hillside, alone, in the presence of stars. The picture must have the real quality of night, for children have said the sky seemed to grow lighter or darker as they looked at it; that sometimes only one or two stars could be made out, and sometimes more. It connects itself in idea with a fragment from Whitman which children can understand:

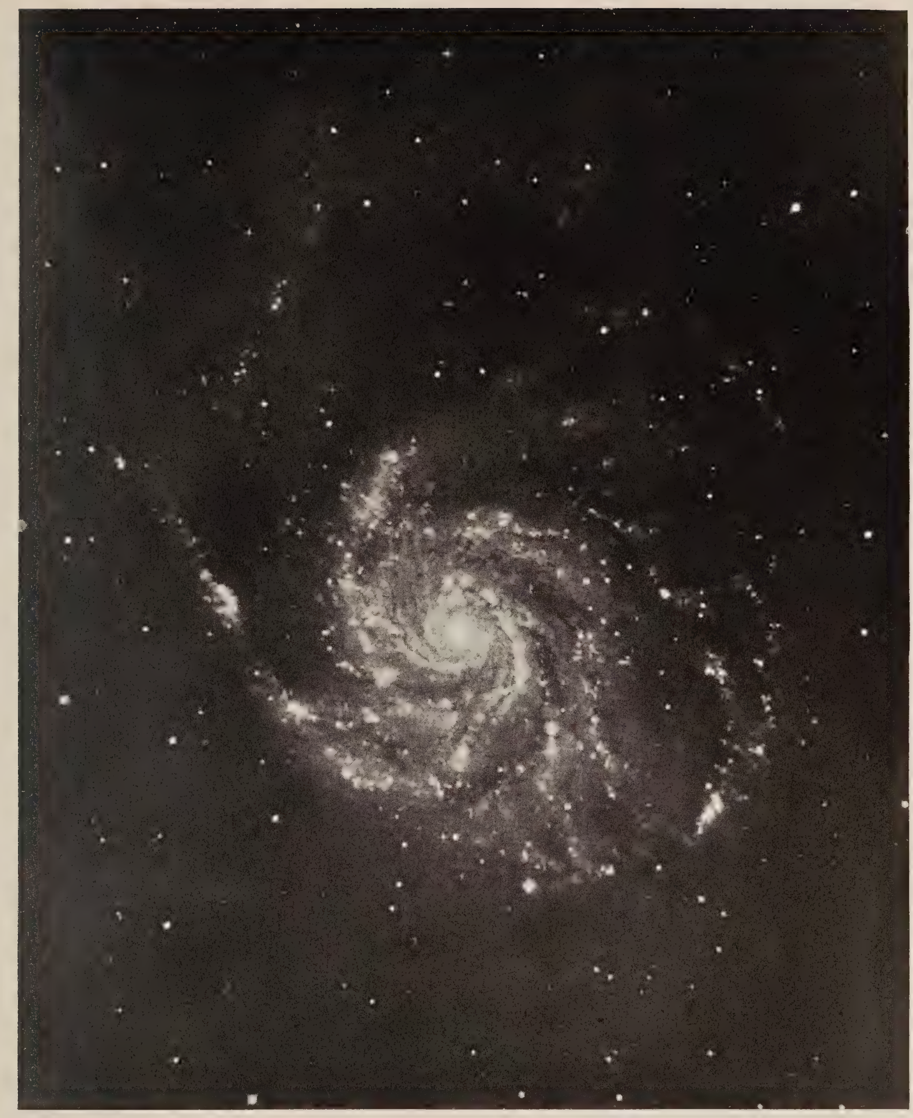
> Till rising and gliding out, I wandered off by myself
> In the mystical, moist night air, and from time to time
> Looked up in perfect silence at the stars.

Thoughtfulness such as this picture promotes should be given its due of time. Requests have sometimes been made to take the picture home that it may be lived with overnight or during a week-end. If star study is opened in this or some similar way, thoughtfulness and reverence are likely to be a part of all the procedure which follows.

In selecting topics relative to the earth in space, the development of the children has been the chief guide; furthermore this development has necessarily affected the way in which

---

[1] Prints of this are obtainable from The Curtis Publishing Co., Philadelphia, Pa.



Mt. Wilson Observatory

MESSIER 101. SPIRAL NEBULA IN URSA MAJOR. THOUSANDS OF NEBULAE IN THIS FORM ARE DISCOVERED BY OBSERVATORY TELESCOPES

topics are handled and the amount of time given to them.

The list given below is a summary of what has been found practicable for children seven and eight years old. Topics which relate to daily experience have been considered most thoroughly. Some of the others have been referred to merely. The reader of this chapter should keep in mind continually that its topics and illustrations are drawn from a number of years with several groups of children, and that only a part of this total has been included in a single year. Crowding children with experience or information would defeat the primary purpose.

The earth in space

The sun Light The spectrum

The origin of the solar system Gravitation Orbits

Planets Satellites

Day and night

The year and its seasons Climate

The earth's moon The months Tides Eclipses

Comets Meteorites

Stars Constellations Star clusters Galaxies

Nebulæ

The universe as a whole.

By the age of seven environment and the general experience of living have, as a rule, communicated to children somehow the news that their world is a ball. A map globe of the world has already become, for most children of that age, a familiar, identified object although the real significance of it may not have reached them. This much then rarely needs to be introduced because it has been unconsciously, or at least informally, appropriated.

The first group experience has usually been to look at and handle a large globe, first locating some familiar and if possible nearby feature which shows the children, for example, that at this spot on the globe the river adjacent to their city is represented by this thread-like line; or that this disk of blue stands for the lake they go to in summer. The brightly colored portions they understand as land and the large blue expanses as sea. It is possible to obtain a twelve-inch inflated rubber globe on which the continents have been traced in outline. Globe acquaintance has been promoted by using this and letting the children color its land and water divisions. They have been helped to appreciate proof of the rotundity of the earth by the common illustration drawn from ships whose tops appear on the horizon before the lower parts of their structure are seen. They have tried this out for themselves with paper boats and the globe at hand. They have been helped to understand the apparent flatness of the earth's surface by looking at the globe through a tiny aperture pierced in a piece of paper.

When a mental connection has been established for the children between the earth they are living on and the globe which represents it, they have been made ready to come into a concept of the earth as poised in space; for the ball must be somewhere. Then comes the natural question, "What keeps it from falling?" At this point a smaller and more easily handled globe, has been needed for very practical illustrative use. Out in the open, it has been thrown high and far. For an appreciable period of time the globe rides in space, although it falls in the end. An approximate demonstration of a world in space has thus been given; the suggestion of movement in a course has been made, and the idea of poise as opposed to falling, has been associated with this movement. The children's next thought may be that the globe moved through space because of the force of the initial push which throwing gave it, that with the decline of the force, the globe fell. The question which is likely to result, "How did the earth get a push?" has opened the way to discussion of the origin of the earth and the other members of the solar system. This discussion has resulted in their receiving information of the planetesimal theory; also the information concerning the tendency of bodies in space to move on orbits, which this theory provides.[2] Play with magnets, bringing out magnetic induction, has helped children to a concept of gravitational force acting through space. A poetic, but realistic, description of the earth in space which appeals to children is provided by Jane Andrews, in a book written long ago.[3]

The idea of a poised, moving earth having been gained, it has then been possible to relate the earth, in thought, to the universe of which it is part. Actually looking at the stars with the children and talking about them together is the logical way of taking this next step; but in day schools which assemble children from a distance it has not been easily arranged. To meet this situation a picture has been made to serve for a group experience, which individual children could follow up at home by looking at actual stars. A picture which has proved its adequacy for this purpose is a transparency called The Christmas Wreath.[4] This shows a little snow-covered cottage under a dark, gray-blue sky of night. When it is hung where the daylight or other light shines through it, the lamp in the cottage window takes on a soft, golden glow and myriad tiny stars gleam out in the sky.

---

[2] See Rollin T. Chamberlin: The Nature of the World and of Man. University of Chicago Press, 1928. p. 31. Also, A. S. Eddington: The Nature of the Physical World. pp. 169-178; and Sir James Jeans: The Universe Around Us. Macmillan, 1929. pp. 39-43.

[3] Jane Andrews: Seven Little Sisters. Ginn & Co., 1861.

While looking at these stars, little ones and big ones, questions of their distance, and what makes their brightness, come out. The children may then learn that most of the so-called stars are suns shining by their own light as the earth's sun shines; that others may possibly be worlds shining by virtue of light they reflect.[5] The earth, they have learned, must shine in this latter way reflecting the light of its sun. One of the brighter, nearer stars in the picture has been selected as a possible world; and a journey has been imagined from the little cottage out through space, toward this so-called star. As the goal is neared the light of the seeming star diminishes, and gradually the surface features of a world becomes apparent in its place. When this far-away world is reached, the traveler imagines himself stepping out upon it. He looks back then to the world from which he came, the earth; and behold, it appears to be a star, like any other, though possibly nearer and brighter.

From some such introduction children have passed to a consideration of suns, planets, moons and other celestial bodies, their interrelations, and their movements in space.[6] At least once in the course of their study the children have come together after dark, to experience the heavens as a group. A sleigh-ride has sometimes been made the occasion.

[4] Tudor Art Transparencies, 7 Parley Vale, Boston.

[5] Kelvin McKready: A Beginner's Star Book. p. 9.

[6] See same, pp. 62-96. Also, Forest Ray Moulton in The Nature of the World and of Man. pp. 5-19. Rollin D. Salisbury: Physiography, Henry Holt & Co., 1913. p. 482 ff. Sir James Jeans: The Universe Around Us. pp. 16-22 and 39-43.

Realization of these interrelations and movements seems to come to children most readily through dramatization. But in order that children shall at all times keep in mind the fact back of the illustration, daily and nightly actual experience in locating and watching sun, planets and moon is a necessary part of the work for individuals; and this needs to be reported upon and discussed in the class group.

A child's poem suggests the following mode of dramatizing the solar system: one child represents the central sun; nine children are planets, and to each of them a planet name is given according to his size. The play begins with the planets stationed at their approximated relative distances from the sun, Mercury nearest and the Trans-Neptunian planet farthest away. Simultaneously the planets revolve, each in its own orbit. Uranus has a retrograde direction, the others a forward one. All except Mercury rotate as they revolve. Mercury finds himself engaged in dizzying numbers of revolutions while the Trans-Neptunian planet has made barely appreciable progress on the great journey his orbit compels. When playing indoors, children have moved to music, with silk scarfs to aid their movement's rhythm.

Similarly, three children as actors have dramatized the moon moving around the earth while the earth moves around the sun. Two children, playing respectively the parts of sun and rotating earth, have illustrated the phenomenon of day and night. Six children have played the cycle of the seasons: one of them is the central sun; one is the rotating, revolving earth; and four, stationed at equidistant points on the earth's orbit, are the seasons which the earth passes through in its year-long journey around the sun.

Three actors have been required for a comet play: the comet, the sun and the earth. The comet travels on an elliptical orbit around the sun, coming from and returning to a region beyond the outermost limit of the solar system, and crossing the earth's orbit in its course.[7] A scarf, of a color which suggests light, has been carried aloft by the running child who represents the comet, and unfurled with greatest freedom when the part of the comet's orbit nearest the sun is passed. If the comet being played is one of known period, it returns to sight after a definite interval of absence and repeats its swinging course.

When playing of this sort is started, children's invention seeks to extend it. The function of the teacher, or other adult, becomes that of making sure that the ideas underlying it are clear and correct. Dramatization of the movements of bodies in space makes it imperative to know that children understand that while we may have visual evidence that these bodies have moved we cannot at any time, on account of their great distance from us, see them moving. The purpose of this playing is imparting information; and care has been taken to keep imagination from altering the factual ideas which it is desired to portray.

What is outlined here is an imaginative way of illustrating scientifically accepted truth; and it has been considered important that the children themselves should realize this. I am convinced that children are capable of making mental distinctions of this kind if situations are put to them clearly. This capacity was referred to in the preceding chapter. After play of this kind has been engaged in as a base for understanding, the factual information it represents can be read to children profitably from texts.

Further illustrative aid in learning the relations and move-

---

[7] See Simon Newcomb: Astronomy for Everybody. Garden City Pub. Co., 1925. pp. 266.

Yerkes Observatory, University of Chicago

BROOKS' COMET, 1911. AS RECORDED BY THE CAMERA THE COMET IS A REVELATION OF ETHEREAL BEAUTY

ments of bodies in space has been supplied by simple mechanical devices. A series of clay spheres which the children make themselves has been found to have many uses. These have ranged in size from a tiny ball a half inch or less in diameter to the largest size which is manageable, in weight. If this largest one is designated permanently to be the sun it has been painted gold or yellow to represent light; spheres accepted as the earth and the moon on a relative size basis have also been appropriately colored. Other spheres have represented the remaining planets and their moons. Of course the size relations which can be indicated thus are only those of planets and moons; the greater range from sun to planets cannot be represented in clay, or by any indoor means. On a large table, the floor or other flat surface, these spheres have been placed in their proper positions with regard to the sun and then moved about to show their established orbital courses.

The earth's day and night and other phenomena of light have been most effectively demonstrated in a darkened room. A bulb of light, suspended at a height of about four feet from the floor for children considered here, has represented the sun. A clay sphere or a globe has represented the earth. A sphere which has been painted in light tones to show continents and oceans serves best. A marker of some kind is put on it to denote the region in which the children live. One of the children holds the sphere at a little distance from the bulb, where it easily receives the bulb's light; and it is, at first, held in the correct position with reference to the marker to represent the time of day at which this demonstration is being made. The sphere is then rotated, the children understanding that each complete rotation requires twenty-four hours of our time. As the hemispheres glide alternately into light and shade, the children watch the marker, calling out if they wish its morning, afternoon, noon, evening, midnight, and so on. At any of these stages the realism has been helped by letting children state the time of day which people on the opposite side of the world, in Australia, China, or on the Pacific or Indian Oceans are simultaneously having.

For explaining the earth's seasons a globe or sphere has been used which has a rod through it to represent the axis. An orbit is determined upon at a convenient distance from the light. One of the children, holding the globe, walks around the orbit keeping constant the angle of the axis with the plane of the orbit. With a marker to indicate their local region, the children have been helped to realize that summer is experienced in this region when sun rays reach it most directly; that winter comes when it is most inaccessible to direct rays; and fall and spring are periods of transition. In other words, this region has summer when the inclination of the earth's axis tips it towards the sun; winter, when it tips it away from the sun. With this same set-up of equipment, polar and equatorial climate have been explained.

The best device I have seen for illustrating the phases of the moon, eclipses and other sun, earth and moon relations, was worked out by a boy of eight with the bars, discs, screws, nuts and bolts of an Arkitoy equipment. A pulley system provided the movement of revolution. A lemon and a plasteline ball, suspended on threads, represented earth and moon; an electric bulb served for the sun.

The appearance, though not the cause, of eclipses has been illustrated by a different device. For this are needed a darkened room and an illuminated projection screen. From a piece of oil-cloth or other opaque material the size of the screen a disk is cut. This material is fastened across the front of the screen. The light of the projection lantern shines brightly through the circular cutting, causing it to look like a round moon or sun. Back of the screen and close to it a tray or other flat, round object slightly larger than the disk is passed slowly across the disk until it is completely covered and all its light disappears. This is the moment of total eclipse. The passing of the tray is then continued slowly until gradually the eclipse becomes over and the whole lighted disk appears to the view once more. Whether a sun or a moon eclipse is being shown is determined by the direction in which the tray is moved. It is surprising how impressive this demonstration can be, if performed with sufficient slowness and steadiness. Of course such a make-believe experience as this is not to be substituted for the real one of direct observation, when that is obtainable, but it may be a useful supplement to it.

The use of an illustrative device, with time for explanation and discussion, can help to make the witnessing of actual occurrences more understandable. But it is the part of wisdom to keep these devices from being used often enough to become a kind of game. The interest should be centered in the actuality of the thing represented, and not in the method of illustrating it. It has seemed important to select among devices, using only the one or ones needed in a given case in aid of clear understanding.

Children have been encouraged to read, or to have adults read to them, the astronomical forecasts in Nature Magazine, The Science News-letter, almanacs, the daily papers or other serial publications. From these sources they can learn when certain planets will be most easily visible to them, when total or partial eclipses are to take place, or when meteorite showers are expected. From such experience they have had opportunity to receive impressive evidences of a universal scheme so orderly as to be minutely calculable; and to become poignantly aware of the achievement of science in being able to bring these facts to light. So far as possible, ways have been found for letting them witness the expected events. They have been taken to an observatory, too; but not until they have worked long enough to acquire the background that is needed to make this privilege intelligible and profitable. In some museums they have been able to see meteorites; also large illuminated photographs of celestial bodies.

The best text I know for direct use with children in observational astronomy is A Beginner's Star Book.[8] Moreover it contains many beautiful and interesting photographs. A general text, which children can read themselves, is The Book of Stars; [9] but its information needs now to be checked with the more recent findings of science. Most of the books referred to in this chapter for adult reading have, in selected parts, been used as text material which can be read, not by children, but to them.

Play with magnets is essential to children's realization of the cosmic system; for magnets point the answer to some of children's most searching questions concerning the earth and other bodies in space. A bar magnet, at least two powerful horseshoe magnets and iron filings are necessary to a reasonably full appreciation of magnetic properties. When children are first introduced to a magnet, it is enough to let them see its power to operate through space, or through wood or paper or glass. Of their own initiative they can discover attraction and repulsion, the relation of pull to mass and distance, the possibility of communication of magnetic property as from magnet to nail, the interplay of magnetic pulls proceeding from different sources, and the lines or patterns produced in a magnetic field of force; and they may adventure interestingly with the property of magnetic induction.

---

[8] Kelvin McKready.

[9] G. E. Mitton. The Macmillan Co., 1928.

Magnetic force with its fundamental polarity, and the force of gravitation, are not considered to be the same thing, but experience of the action of magnets makes it possible for children to carry over into their concept of gravitation the ideas they have gained concerning the power of an invisible force to act across space.[10] Thus, from intelligent play with magnets, children are helped to an understanding of the gravitational influence of our sun, or a visiting sun, upon our earth and the other planets; of the influence which planets and moons exert upon each other; or the attraction which pulls a comet towards the sun.

When the topic for study is the sun,[11] children are in the presence of endless opportunity for mental unfolding. They can grasp the idea that the sun shines, not only upon the earth but through space in every direction, and inconceivably far beyond the earth's orbit. Looking at the lighted area surrounding a candle flame in a darkened room can help this realization, the best effect being obtained when the candle is held at arm's length. So, also, can the following statement from Burroughs: "We may fancy that the sun is in the heavens solely to give light and warmth to the planets, which it surely does, but behold what a mere fraction of the light and heat of the sun is intercepted by the slender girdle of worlds that surround it; the rays go out equally in all directions, they penetrate all space. The sun, with reference to its light and heat, is at the center of an infinite hollow sphere, and not one millionth part of its rays falls upon the worlds that circle around it." [12] However, as Burroughs says elsewhere, man benefits as completely from all this outpouring of energy as if he were the sole beneficiary of it.[12] Shelley helps one to see the sun's light and the earth in a detached way when he makes the earth say, "I spin beneath my pyramid of night." A beautiful concept of the sun radiating its light upon a world, through space, is provided by Doré's painting, The Creation of Light. Reproductions of this are obtainable easily.[13] In a degree, the strength of this picture, its detachment and its high relief of illumination and shadow are present also in some lines of Whitman which make a sure appeal to children:

---

[10] Regarding gravitation, see Simon Newcomb: Astronomy for Everybody. pp. 243-252. Also, Rollin T. Chamberlin in The Nature of the World and of Man. pp. 32-36. Regarding magnetic attraction, see Clarke and Small: Boys' Book of Physics. E. P. Dutton & Co., 1922. pp. 210-213.

[11] See Kelvin McKready: A Beginner's Star Book. pp. 62-69; and Simon Newcomb: Astronomy for Everybody, Part 3, Chap. 2.

I see a great round wonder rolling through the air,

I see the shaded part on one side where the sleepers are
sleeping

And the sunlit part on the other side.

I see the curious, silent change of the light and shade

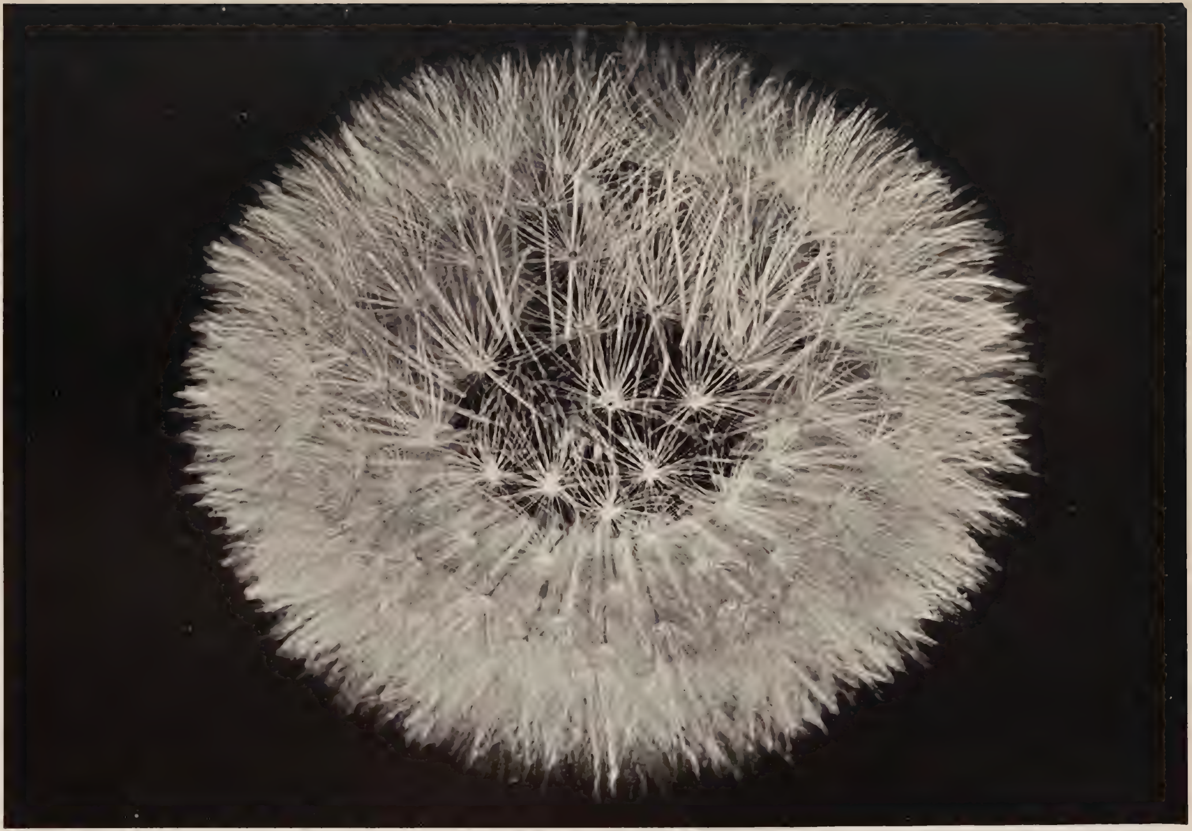
And distant lands as real and near to the inhabitants of them

As my land is to me.

To every child diversity of sun experience is open in that he is able to see and in some measure to understand the appearance of sunrise and sunset, the sun's light breaking through clouds, the semblance of rays in the phenomenon

---

[12] Accepting the Universe, pp. 64, 65.
[13] Perry Pictures Co., Boston, Mass.



Cornelia Clarke

THE DANDELION HEAD IN FRUIT IS A DOME OF FAIRY-LIKE STRUCTURE. ENLARGED

commonly known as drawing water, the rainbow, the apparent daily march of the sun across the heavens; and he may perhaps see an occasional eclipse. The impression which all these things can make upon consciousness has rare value of its own, in addition to what they can impart in the light of the discoveries of science. Mr. Eddington, after asserting that the rainbow (to science) is (a) matter of wave-lengths, goes on to make this statement: "We cannot say that the rainbow as part of the world was meant to convey the vivid effects of color; but we can perhaps say that the human mind as part of the world was meant to conceive it that way." [14] Mr. Whitehead points out that one who knows all about the sun, the atmosphere and the rotation of the earth may still be in danger of missing the radiance of the sunset. He says there is "no substitute for the direct perception of the concrete achievement of a thing in its actuality.[15]

Children, in this study, have been encouraged to see all of a sunrise, from the first faint heralding irradiation; to see one phase merge into another, the pale pink sky of dawn perhaps passing into deepening color and gleam-tipped clouds, until the moment comes when the final glory of the whole sunrise bursts forth. As the brilliance of color fades, they may have seen the round, golden sun appear and the new day fully begin. This can seem in consciousness like a color-costumed, rhythmic dance. They have been encouraged to see all of a sunset too, and have noted perhaps that this may differ from sunrise in brightness, warmth and reflection of color; and that in sunset the radiant glow follows the sun's disappearance instead of announcing its coming. The cause of sky coloration has usually been explained somewhat at this point of study; but it has been gone into more thoroughly later when the subject of The Earth's Atmosphere is considered.

---

[14] Nature of the Physical World, p. 329.

[15] Science and the Modern World, p. 286.

The fact of the inclination of the earth's axis, coupled with the fact of the earth's revolution, produces the illusion of a north and south sun journey.[16] When the earth is in the position of winter solstice, December 21, the axis is for our latitude tipped away from the sun and the sun's rays fall vertically on the Tropic of Capricorn. Six months later, on June 20, when the earth is in the position of summer solstice and the axis is tipped toward the sun, the sun's rays fall vertically on the Tropic of Cancer. At the end of another six months, on December 21, the rays again fall vertically on the Tropic of Capricorn. The effect, so far as the earth is concerned, is that the sun traveled north from Capricorn to Cancer, and then south again to Capricorn. This is an explanation which as a rule has not been offered to children seven and eight years old.

However, they can carry out a simple experiment in this field which can at least serve as one more illustration of cosmic order which science has discovered and is able to calculate exactly. The experiment is suggested by the writer of a nature study text.[17] To part of a group can be assigned observation of the rising sun, and to another part observation of the setting sun, within a period of days leading to and following the winter or summer solstice on December 21 and June 20. Observation is prepared for by choosing a suitable window, or some definite outside location, as the view-point; also by making a drawing of the horizon as seen from this view-point, plainly indicating each tree, house or other object that cuts up into it. Of course the children who are to observe the rising sun draw the eastern horizon and those who are to observe the setting sun draw the western. It is necessary to go to the selected spot a few minutes before the scheduled time of sunrise or sunset. At the moment of the sun's appearance or disappearance a dot is placed on the drawing in the spot which indicates the sun's location exactly. Beginning with the first day's observation the dots are numbered. The experiment continues long enough to show that the dots move in one direction until the critical date is reached and then reverse their direction.

---

[16] See Rollin D. Salisbury: Physiography. pp. 499-502.

[17] Samuel C. Schmucker: The Study of Nature. J. B. Lippincott Co., 1908. p. 248.

For the experience of children, also, are all those earthly examples of marvelous beauty and interest which reflected sunlight produces. They have discovered avenues of delight in radiance, shine, iridescence, flash and sparkle, and have learned to distinguish these one from another. They can supply the imagery for a Japanese Hokku like this one:

Cherry blossoms in sunlight!
I lean upon my staff and pause
To see their loveliness.

Light radiated and reflected, is a productive idea in consciousness. John Burroughs says that life and light are the positive facts in nature, and death and darkness the negative.

Children have become aware too of such properties as transparency, translucence, opaqueness. Translucence they find in a surprising range of manifestations; it appears in stones, flowers, seeds and other natural forms, and may enhance them with exquisite beauty. They have wondered over the significance of shadows and over the likenesses and differences which shadows and reflected images, considered together, exhibit. The shadow of a floating leaf, stick or insect, outlined in light, is one of the diverting experiences which an outdoor pool affords. So also is the colored reflection of sky and cloud.

A simple experiment with shadows, which shows the relation between sun rays and earth rotation is provided when children go out-of-doors early in the morning, at noon and in the afternoon, to note the differences in direction, length and distinctness which their own shadows make at these times. And if a tack is put where the shadow of a window pane strikes the floor the children observing it are likely to be surprised to see how rapidly the shadow moves.

A practical plan for systematic observation and recording of sun shadows from day to day is that of noting the changes of some specific shadow. For example, a spot is found where at twelve noon the shadow of a building shows plainly on the ground. Exactly on the corner of the shadow and exactly at noon a small square of paper marked with the date is nailed to the ground. The next day and following days, as the weather permits, the procedure is repeated. The discovery is made that the shadow grows shorter day by day in the period between December 22 and June 20, and longer in the other half of the year. If the experiment is carried on through these dates in two successive years, a convincing demonstration is made of the regularity of the cosmic movements involved.[18]

The purposes of observation are served further by the use of a sun-dial; also by the game of shadow tag played at various times. Taking photographs of shadows provides for children an attractive and perhaps informing diversion. Shadowgraphs, as a device for bringing out the beauty of natural forms, are referred to in the chapter on Beauty and Rhythm.

---

[18] See Samuel C. Schmucker: The Study of Nature. pp. 247, 249.

The opportunity to play with a good glass prism is indispensable to the study of the sun's light. An eight-inch triangular one is best. Many creative things can be done with a prism, apart from its primary purpose to produce the spectrum. One who has never looked through a prism at the world of out-of-doors and does not know the infinitely varied, fairy-like transformations in color which this world assumes when thus looked at, has a radiant experience awaiting him. Walking with a prism and looking through it downward, provides another surprise. The need to keep changing the position of a prism in order to permit it to receive direct sunlight continuously, and the consequent altering of the location of the spectrum, afford possible evidence of a moving earth. The spectrum made to traverse color drawings, plants or other objects in a room sometimes bestows beauty upon them to an arresting degree.

Understanding of the spectrum has been promoted by dramatization. As an aid to this, scarfs have been dyed by the children to correspond to the spectrum colors. One person represents the sun. Another, aided by a white scarf, is a ray of white light. Six or seven children, with the colored scarfs, are the separated color rays of the spectrum. The prism lies on the floor at some distance from the sun. The white ray runs from sun to prism. Then the color rays, to this time supposedly unnoticed, run in fan-like formation from the opposite side of the prism to the wall beyond; and there, in spectrum order, their colors are displayed. The making of a rainbow can be dramatized by a similar plan. Children studying the universe have in some instances been told something about spectrum analysis,[19] and have learned that this has helped astronomers to acquire knowledge of the composition, distances and motions of stars, including our sun.

---

[19] Regarding spectrum analysis, see Forest Ray Moulton and Harvey Bruce Lemon in The Nature of the World and of Man. pp. 18, 92-97. Also, Kelvin

Other sun topics included have been the sun's relative size with regard to the earth and its distance from it, the nature of sun spots [20] and their relation to knowledge of sun rotation, eclipses of the sun,[21] and theories concerning the source of the sun's heat.[22] Discussion of sun heat has opened up another set of experiences. Children have been helped to the discovery that by letting direct sun rays pass through a lens, a match can be ignited or a hole can be burned through a leaf. They have dug into the earth on a warm, sunny day and discovered how quickly a depth is reached where the soil is cool and moist, perhaps from lack of exposure to sunlight. They have imagined together a world deprived of the sun's energy in the forms of heat and light. They have recalled what they have learned or experienced of seasons and climate, and have considered the relation of these to the phenomena of plant and animal life.

The moon as a topic for consideration has intrigued children with its own beauty and that of the effects it produces. Children watch the moon with lasting impression when it looks serene and still in a clear expanse of sky. It provides then the experience of Blake's lines:

The moon, like a flower
In heaven's high bower,
In silent delight
Sits and smiles on the night.

McKready: A Beginner's Star Book. pp. 140, 141; Simon Newcomb: Astronomy for Everybody. pp. 73 ff.

[20] See Kelvin McKready: A Beginner's Star Book. p. 66.

[21] For interesting photograph of the eclipse of 1925, see Simon Newcomb: Astronomy for Everybody, Frontispiece.

[22] A. S. Eddington: Nature of the Physical World. p. 169.

Cornelia Clarke

DANDELION FRUITS READY TO SAIL WITH THE WIND. ENLARGED

Coincidence of children's play time and moon time is not likely to occur; but when it does, the children are likely to make a game of the discovery that when the moon is seen thus, in an unclouded part of the sky, it seems to stand still when they do or to keep pace with them when they walk or run. They have found amusement also in watching the moon when it seems itself to play a game by peeping through clouds or hiding behind them; and they have enjoyed its dramatic beauty when it rides gloriously through cloud billows, touching the darkness with light. As they have had opportunity, they have found pleasure in seeing the moon's image in water, or a reflected moon path.

Children, in company with Japanese artists and poets, find pleasure also in seeing objects silhouetted against the moon. In our country these objects may be perhaps a branch of a tree, a spray of flowers or trailing vine, a weather vane, a windmill, a spire, a tower, or smoke-stacks. When interest is active in this kind of observation, enjoyment has been increased by looking at Japanese prints which illustrate the same idea in Japanese terms. Another effect of the moon which children are sure to notice is the magic of moonlight on house or tree, or ground, and they are likely to appreciate such poems as Walter de la Mare's Silver, or Japanese Hokkus which follow this theme. In such awareness a little boy wrote:

I wander, wander
Far away
I wander, wander
All the day
Till night falls down.
The moon appears
And fills the grass
With silver spears.

The moon, the flowers and the snow constitute in the mind of the Japanese poet a trilogy of nature's most beautiful manifestations. It is to be expected therefore that many Hokku poems should make the moon their subject. Some of these, which children have enjoyed, are quoted below. The first two especially illustrate the Japanese characteristic of making demands upon the reader; for whatever value he gets from them is supplied by his own understanding and his own imagery. All these poems children have made the subject of dramatization and painting. In this work the qualities of simplicity, imagination and beauty inherent in the poetry have been manifested in a special degree. The title of the first poem is The Full Moon.

It was the new moon. Since then I've waited
And lo, at last, tonight!

O moon, if born again I'd be
A pine tree, on a mountain peak.

In the ocean of the sky
Rising on the waves of cloud
The moon-ship goes agliding by.

The moon is shining bright
And round my white narcissus bed
The foxes play all night.

The moon, for purposes of study, is conveniently near; and by reason of its second-hand illumination it is dim enough for prolonged scrutiny. Lighted and shadowed areas are easily discernible. A clear description of these, designed for children, is the following:

"A study of the geography of the moon for a few nights will fix firmly the idea of the moon being a spherical body provided with mountains and plains and revolving in space. It is the one object lesson to help pupils really conceive of the earth in any clear fashion. The early astronomers who named the markings on the moon called the ridges mountains, and in this later observations proved them to be right. But the flat smooth patches they called seas, and in this they were certainly wrong. We now know there is no standing water on the moon, and possibly no water of any kind. But the old name of seas is so firmly fixed that these patches will possibly always be called seas.

For the purpose of fixing these features on the children's minds it will be not inadvisable to carry out the old idea of the man in the moon. When the moon is full, its entire surface may be taken to represent the face of a man, turned so as to bring his left cheek to the front, his nose being turned somewhat to the right of the center. The nose is formed by the most prominent range of mountains on the moon, known as the Apennines. The right eye is the Sea of Showers and the mouth is made of two seas, the right side the Sea of Storms and the left the Sea of Clouds. The left side of his face is not so gloomily named. The left eye is the Sea of Serenity, the left ear that of Tranquillity and Nectar combined, Tranquillity being above. Just back of and above the ear is the brightest patch of the moon. It is known as the Sea of Crises. Two volcanoes are apparent to the observer, Copernicus on the tip of the nose and Tycho on the lower part of the left cheek near the chin."[23] With the aid of a small telescope the conformations of the moon's surface can be seen much better; and an observatory telescope or a stereograph can add the suggestion of rotundity.

---

[23] Samuel C. Schmucker: The Study of Nature. p. 250.

The moon, with suitable telescopic aid, seems to provide for children the best means obtainable for realizing astronomical facts. I find that certain stereographs of the full and three-quarter moon, made at Yerkes Observatory, serve this purpose better than a direct telescopic view.[24] Stereographs can be looked at repeatedly and with deliberation, while most telescopic viewing by the public at observatories is necessarily hurried. Making drawings of the moon from direct observation is also a helpful procedure. Starting with the young crescent, children can have profitable pleasure in drawing the moon as it appears night after night or in the daytime, and shows gradually its phases of young moon, full moon, waning moon, new moon, and once again young moon.

These successive drawings of the moon's phases make an interesting and attractive chart even though many spaces have to be left to indicate nights or days when the moon could not be seen because of weather or other conditions. They illustrate one of nature's orderly cycles and they give evidence of a cosmic procedure important to the earth. Such drawings have meaning only as children understand the moon's movement with relation to the sun and the earth. Ways of communicating this were suggested in the beginning of this chapter. The moon has been referred to at this point of study as the cause of tides, but the topic has been dealt with more satisfactorily at a later period when the children are learning about the oceans.

The writer whose description of the moon's surface has been quoted here suggests also that it is an interesting and beautiful observation to draw the moon and the three or four nearest stars on one evening and then to repeat the drawing on the next evening, at the same time. He points out that no other such rapid change of position amongst the stars will be noticed on the part of any heavenly body except a meteor. Other topics of moon study have been eclipses[25] and the theories concerning the moon's origin.[26] The fact that the moon is not an ordinary satellite has been brought out, in that no other known satellite is nearly so large in proportion to the planet which it attends.

---

[24] These can be obtained from The Keystone View Co., Meadville, Pa.

Stars as a topic for study have been presented to children without any reference to the mythological tales and terms which have been current throughout the ages. These belong rather to the study of human history. If one wants the established facts regarding the heavenly bodies to be believed the admixture of irrelevant fable can only hinder and becloud this purpose. If children are not prohibited by their home circumstances they are likely to watch the stars nightly or at least frequently. As a result of continued observation they become aware of the location of certain stars; and in some instances they have watched night after night for the appearance of some star of special brightness. A little girl, not yet discriminating planets from stars, wrote the first quotation which follows. A little boy wrote the second and called it October.

One night I saw the brightest star
And it was Venus.
And then the night began to break
The early morning light came in
And the sun shone out.

---

[25] See Simon Newcomb: Astronomy for Everybody. pp. 133-138.
[26] See Sir James Jeans: The Universe Around Us. pp. 227-229.

When all the leaves turn yellow
And the berries all turn red
Then I say "It's beautiful"
In the misty afternoon air.

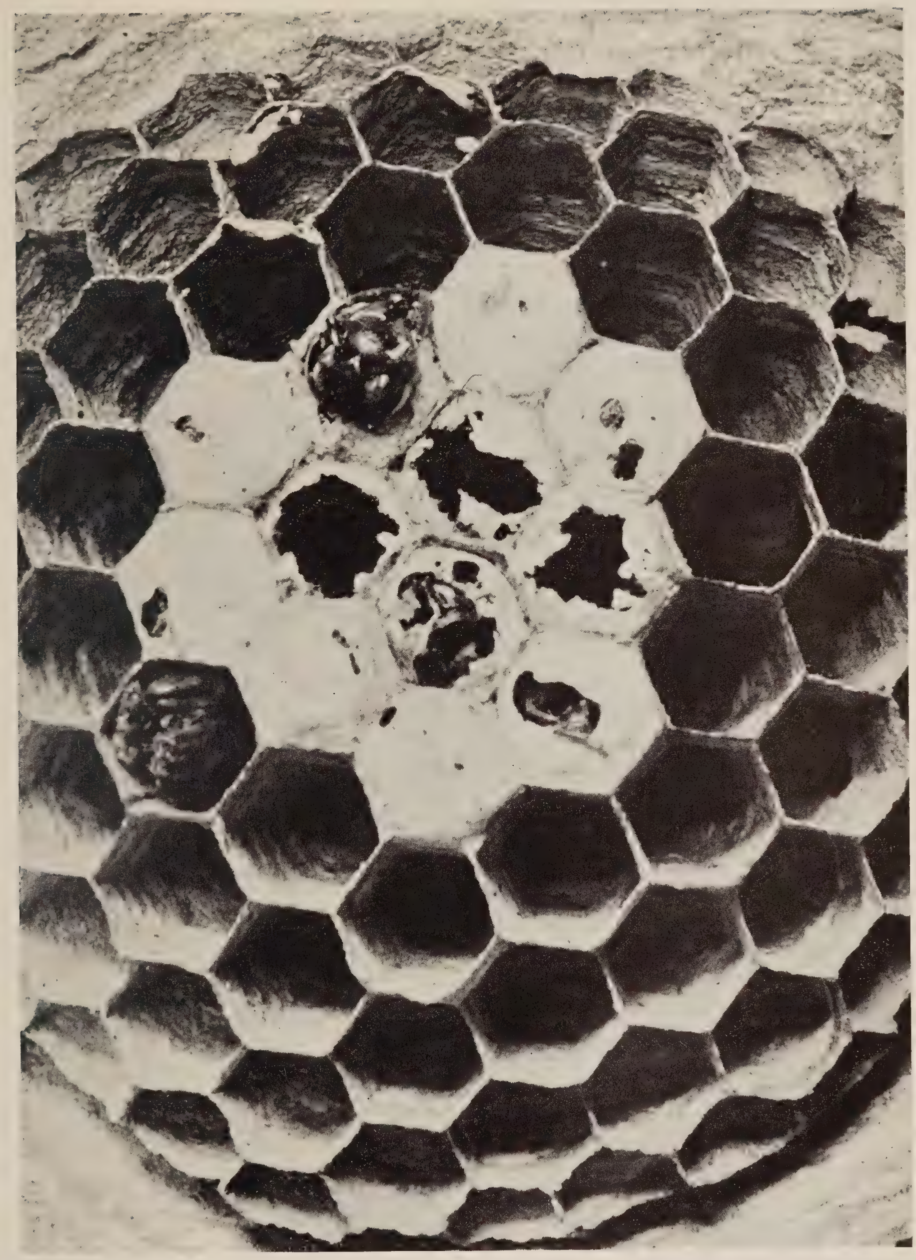
When all the birds are quiet
And the sunset just has gone
Then I see the first star
In the cool night air.

Christina Rosetti's Song of the Star, Sappho's Hesperus, Sara Teasdale's February Twilight, the music of Wagner's Evening Star, and the opening lines of John Masefield's Sea Fever are similarly associated in thought with awareness of some single, selected star.

Children have noticed also that some areas of the sky seem to hold more stars than others do. On a clear, dark night they may be appalled at the number and brightness of the stars in the sky as a whole. With binoculars, the experience is extended surprisingly. They have become aware in some instances of what seem to be twinkling stars and still ones, and of stars of differing colors. There has been discussion together concerning what the stars are made of, and on what astronomers base their claim to know this; of the possible number of stars, their age, and their distance from the earth and from each other.[27] No one's mind compasses star numbers, ages, or distances as scientists can compute them; the information supplied seems like infinity demonstrated. Yet, relations can be established in consciousness by simple concrete illustrations, and the mind can be opened to the idea of a creation unlimited if not infinite in space, stretching backward and forward in time, orderly and progressive.

---

[27] See Kelvin McKready: A Beginner's Star Book. pp. 7-17.



Ernst Fuhrman. In Die Pflanze als Lebewesen, 1930.
Societäts-Verlag, Frankfurt-am-Main, Germany

HEXAGONAL CELLS MADE BY WASPS FOR DEPOSITING THEIR EGGS

It has seemed best to dwell for a long time with such observations and discussions before attempting to recognize star groupings in constellations. That such groupings are assumed by scientists for practical purposes the children have needed to realize at some point of their study, for this fact is important to their understanding of astronomical descriptions. It has seemed desirable that they should identify and locate some of these constellations; but knowledge of a few, four or five at most, has seemed much more likely to serve the purpose of clarity than more extended knowledge would be.[28] Those selected have been the dipper, Cassiopeia, the Pleiades, Orion, the great square of Pegasus, Leo—according to the time of year. Also two or three stars of first magnitude, usually Betelgeuze, Sirius, Arcturus, and the Pole Star, have been located and recognized. Planets have been pointed out at astronomically favorable times, as they appear in constellations, and their movements followed.

A simple way of explaining the apparent nightly movement of constellations,[29] through dramatization, is suggested as follows: "We can illustrate it in this way. You, Alice, are the sun, and I will be the earth. The other girls form a circle around me, farther off than Alice. You are the stars. Now I will stand still and you all move around me. It is daytime for I am facing Alice, the sun. The sunlight blots out the stars. Now the sun is setting. Alice is passing back of me. I can see the stars, but they too are moving across my sky. Some are setting and others rising, until the sun comes up again. That is the way it seems to be. We saw the sun set last night and the stars follow. But there's another explanation. You girls and Alice stand still, and I, the earth, will turn. It is day, for I am facing the sun, but as I turn, the sun (Alice) seems to be moving the other way. Now it has gone and I cannot see it but I see the stars. As I turn on to my first position the stars seem to move across my sky. There, I see Alice again. The sun is rising. It is quite clear that the rotation of the earth does explain the apparent motion of sun and stars." [30]

---

[28] See Kelvin McKready: A Beginner's Star Book. pp. 22-29.

[29] See same, pp. 10, 16, 23, 135.

Children have found it interesting and clarifying to make, from large pasteboard dry-goods boxes, a set of transparencies to illustrate what they are learning about stars. A half circle, as large as the dimensions of a box will allow, has been drawn on the bottom of the box, outside. Along the horizontal line which is the base of the half disk thus produced, tiny silhouettes of trees and buildings have been painted in black. The rest of the disk has been painted to represent the great over-arching dome of the sky at night. Other boxes have been similarly prepared. One box has been selected to represent some of the constellations seen when the observer is looking north from a specified location at a specified date and hour; another box has represented constellations seen when he is looking south.

Charts of the current information needed for this work are supplied serially by The Nature Magazine, The Science News Letter, and probably by other publications. Additional boxes have shown the location of planets, the moon, certain stars, or other objects of interest. The children have been helped to make a direct connection between what they see in the sky and what they are representing. Extreme simplicity, eliminating everything unnecessary to the main purpose has been observed. When the representations for these boxes have been determined upon, stars and planets in their correct positions have been pricked through the pasteboard, and the moon has been cut out. The relative magnitudes of stars have been given consideration.[31] Needles of varying sizes and an embroidery stiletto have produced these size relations. White tissue paper has been pasted across the inside of the bottom of the boxes for the purpose of softening and diffusing the light, and the part of the paper which becomes the moon has been painted yellow. The covers of the boxes have been closed over the backs of the transparencies thus made and lighted electric bulbs inserted; or without covers, in daylight, the boxes have been set against a window. In either case the illusion of night and stars is produced and a device has been obtained whereby children can establish a clear sense of the groupings and locations of certain objects in space. The transparency idea has been adapted, also, to a chart of the solar system showing sun, planets and moons, and providing a graphic illustration of the pattern which the movements and relations of these bodies suggest.

---

[30] Louise Brown: All Night with the Stars. The Womans Press.

The photographing of star trails is possible for children, provided they have adult help in focussing and in regulating time exposure. The experience is worth having because it can reveal an effect which earth rotation could cause. If, for example, the camera be pointed at the Pole Star and left exposed five hours or longer, the film will show not stars, but arc-like lines about a center. In the twenty-four hours each star would make a complete circle if daylight did not interfere. The Pole Star makes the shortest arc.[32]

Study of the earth in space has included the attempt to give children some awareness of the relation of the earth and the solar system to the cosmic whole. Looking at the

---

[31] See Kelvin McKready: A Beginner's Star Book. pp. 38-61.
[32] See Louise Brown: All Night With the Stars. pp. 16, 25.

Pleiades directly and learning that astronomers find that these stars seemingly so close to each other are many, many times farther apart than the distance from our sun to the Trans-Neptunian planet, helps children to the realization of the whole solar system as merely a speck in space.[33] Whitman helps further by saying:

I open my scuttle at night and see the far-sprinkled systems . . .

Wider and wider they spread, expanding, always expanding,

Outward and outward, and forever outward.

My sun has his sun, and round him obediently wheels . . .

See ever so far, there is limitless space outside of that;

Count ever so much, there is limitless time around that.

A model of the universe, as he terms it, is supplied by Sir James Jeans: [34] "The earth, traveling 1200 times faster than an express train, makes a journey of 600 million miles around the sun every year. Let us represent this journey by a pin-head 1/16 of an inch in diameter. This fixes the scale of our model; the sun has shrunk to a minute speck of dust 1/3400 inch in diameter, while the earth is a still more minute speck which is too small to be seen at all even in the most powerful of microscopes. On this scale the nearest star in the sky, Proxima Centauri, must be placed about 225 yards away and to contain even the hundred stars nearest to our sun in space the model must be a mile high, a mile long and a mile wide." This much of the description is perhaps all that is really helpful to children; and what follows can only be implied to them. We do not want to overawe children or offer more than they can receive.

---

[33] Regarding the Pleiades, see Martha E. Martin: The Friendly Stars. Harper's, 1917. pp. 222, 225.

[34] The Universe Around Us. pp. 82, 83.

But in any case the paragraphs which follow can help the adult associated with children by making his own concept clear: "Let us go on building the model. We may think of stars indiscriminately as specks of dust, because their sizes vary about as much as the sizes of specks of dust. In the vicinity of the sun we must place specks of dust at average distances of about a quarter of a mile apart. In other regions of space they are generally even farther apart, for, owing to the presence of the 'local cluster,' the immediate neighborhood of the sun happens to be a rather clouded part of the sky.

We go on building the model for hundreds of miles in every direction, and then if we are building in a direction well away from the galactic plane the specks of dust begin to thin out; we are approaching the confines of the galaxy. In the galactic plane itself we build out for about 7,000 miles before we come to the farthest globular cluster, and still we are inside the galactic system. With our earth's long yearly journey around the sun as a pin-head, the whole galactic system is about the size of the American Continent. It may be well to pause and try to visualize the relative size of a pin-head and of the American Continent, before we go on with our mental model-building.

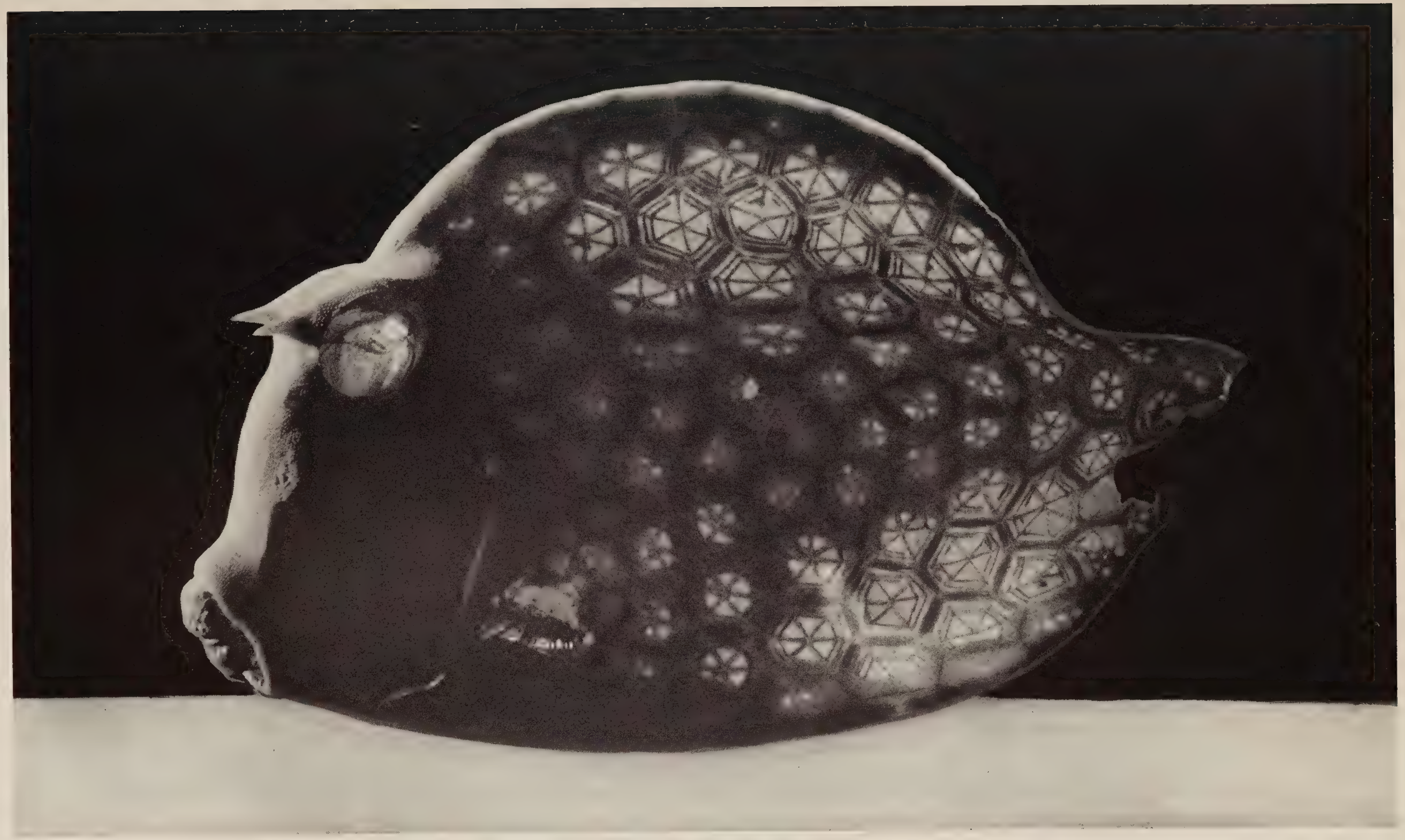
"After we have finished the galactic system, we must travel about 30,000 miles before we begin to set up the next bit of our model, at any rate if we are keeping it to scale. At this distance we place the next family of stars, a family which is probably substantially smaller and more compact than our own galactic family, but is comparable with it both in size and in numbers. So we go on building our model—a family of thousands of millions of stars every 30,000 miles or so—until we have two million such families. The model now stretches for about 4,000,000 miles in every direction. This represents as far as we can see into space with a telescope; we can imagine the model going on, although we know not how nor where—all we know is that the part so far built represents only a fraction of the universe."

Another astronomer has expressed the view that it is not the vast extent in space of the physical universe, nor the number and great masses of stars, nor violent forces, nor long periods of time which hold astronomers awestruck; but it is that from the tiniest satellite to the greatest galaxy there is nothing chaotic, haphazard, or capricious. "The orderliness of the universe," he says, "is the supreme discovery in science; it is that which gives us hope that we shall be able to understand not only the exterior world but also our own bodies and our own minds." [35]

The study of the earth in space and related ideas proves to be an abundant source for creative work of various kinds. Skies of night and day, clouds, sun and moon and their effects, eclipses, comets, and other topics equally potential invite expression through drawing and painting. Pastels or colored chalk, and water colors, have seemed to be for such work the most suitable media. This type of representation may be imaginative or interpretive. It is quite distinct from the literal and almost diagrammatic illustration previously referred to, which has for its purpose the clear apprehension of specific facts and, through series of drawings, the making of the study as a whole connected and clear. Dyeing, an oc-

---

[35] Forest Ray Moulton in The Nature of the World and of Man. p. 30.



The American Museum of Natural History

THE COWFISH IS DECORATED WITH A DESIGN OF HEXAGONS

cupation which children enjoy with most freedom and effectiveness when it can be carried on in the open, also affords a ready means of expression; and it has aided rhythmic pantomime by providing such settings or scarfs as may have been needed. Very simple processes of dyeing have produced the colors of the spectrum and provided effects of the sun with spread rays, the sun or moon breaking through clouds, of sunset and sunrise, of skies and clouds of varying aspect, a spiral nebula, a star cluster, a comet, Saturn with its rings, and other representations.

Poetic thought is likely to be revealed in earth-in-space study, whether in detached expressions, metrical form, or rhythmic dramatization. The child who says that the moon weaves in and out of the clouds or that the night-floating clouds go over the stars has, it may be conceded, a poetic concept. Creative poetic appreciation has perhaps been illustrated by the little girl who unconsciously substituted the phrase "in great stillness" for the "in perfect silence" of one of Whitman's star poems.

The poetic content of children's thinking is sometimes surprised into expression by a practice which I have used throughout this teaching. A single word, drawn from the general subject of study is announced to the group, such as "light," "order," or "space." The children are given opportunity to tell the immediate thought or picture which this word produced in their consciousness. On one occasion the word "radiant" was announced. A boy at once said, "I saw the sun shining on a cloud." Some time later, apparently without conscious connection, he wrote the following:

> The sunlight shines on the clouds
> And lights them up with radiance.

Such instances, wherein a thought or picture thus brought out spontaneously has been subsequently amplified and given form by the child, have not been uncommon.

Rhythmic dramatization produced by children who have had fundamental training in rhythmic movement proves a poetic and beautiful way of working creatively from ideas contained in this study. Such plays, as a rule, are impromptu when first given. They are danced rather than acted. They are likely to be given without music because of the spontaneity of their production and the difficulty of arranging music to fit them. The children are the actors and they may also constitute the setting. The effectiveness of a pantomime and of all rhythmic work to an onlooker, as well as the movement reflex to the participating children, practically demands that the children shall wear a simple, appropriate costume and either have bare feet or wear soft sandals. Silk scarfs suitably dyed to represent nature ideas are needed also. Stage properties, whether the playing is done indoors or out, are usually dispensed with. Sun and moon have sometimes been represented by a wooden hoop, covered with a scarf of appropriate color.

In the examples of rhythmic pantomime which follow, created by children, the playing has preceded the writing, which is merely the children's record for possible future use:

(1) *Night and Day:* In the beginning of the play there is just the night sky and the moon. The moon slowly goes straight across the sky and sometimes a night cloud goes slowly flying in front of the moon. A little star comes out. You have to be watching or you do not see it come. When the moon is gone, across the sky out of sight, the early morning sky comes in, in another part of the sky, and early morning clouds fly around. The little star has to go out of

sight and the night sky goes too. Then the sun's rays shine out and the blue sky of day spreads wide over all.

(2) *Day and Night:* It is early in the morning and the sun's rays come out. The birds come fluttering and sing to each other and to the flowers; but the flowers are asleep. The birds are happy. Then the flowers are waked up by butterflies. They touch the flowers with their wings to wake them, and they suck the honey. The bees come buzzing. The butterflies and bees go on flying to each flower and never leave any flower alone. Then the flowers close up because it is night. The butterflies and bees go away and sleep, and the sun's rays cannot be seen any more, and the sun goes down behind a hill. The birds fly away to their nest.

(3) *Children of Day and Night:* The play has three parts. some children go to sleep as the sun goes slowly down. This is the ending of part one. The moon rises. Some star children with golden star crowns move in a group slowly across the sky. After a long time the moon disappears and so do the star children. This is the ending of part two. The sun comes up. The day children wake up and they are happy, and come running and dancing with branches and flowers and they dance and play till the sun goes down. This is the ending of part three.

(4) *Sun and Moon:* A big, round orange sun goes down out of sight in one part of the sky, and just at the very same time a big round yellow moon is slowly coming up in another part of the sky. It is the opposite part.

Throughout this work, if it is done sincerely and with clearness, ideas of order and harmony are sure to reach the children; for these terms, according to the standard dictionaries, define the cosmos. Beauty and grandeur are illustrated again and again. The children's vocabulary has opportunity to be augmented understandingly by many new and thought evoking words; such terms, for example, as universe, space, infinite, order, system, cycle, light, radiance, reflection, shadow, spectrum, gravity, attraction, force, rhythm, the points of the compass, horizon, zenith, ecliptic, sphere, axis, poles, equator, rotation, revolution, orbit, circle, ellipse and spiral. If the experiences of the work tend to back children up to the inquiry, "How did the sun get made?" and they want to know the source of the first nebula, no harm is done by the honest reply that answers concerning the ultimate have not been found in science. On the contrary, it is a good plan to have children grow up in this kind of thinking; and the faith inherent in childhood will not be destroyed thereby but confirmed.

Because the poetry of Walt Whitman strikes the universal note unfailingly, it has been used all through this study; and it seems indispensable to a summary of the values which the experience has sought to bring out. The prevailing order in the universe is his recurrent theme. He speaks of "the stars, suns, systems that, circling, move in order, safe, harmonious, athwart the shapeless vastness of space." "The universe," he says, "is duly in order, everything is in its place; what has arrived is in its place, and what waits is in its place." Again he says, "All is a procession; the universe is a procession with measured and beautiful motion." Children who have acquired some knowledge of the universe understand and respond to these writings.

IV.

The Inside of the Earth

WHAT does anyone instinctively want to know about any ball which comes to his notice? With a superficial awareness of its size and general coloring and surface aspect, he at once proceeds to wonder what it is made of—whether it is solid or hollow, hard or soft, heavy or light. So it is with the earth ball. With a cursory awareness of its land and water exterior, children want to know its composition all the way through.

The experience has been repeated, in different groups of children, that while still considering the earth as an object in space, some child will say, "But what I want to know is, what is inside of the earth?" Through study of the earth in space they may have learned of a gaseous beginning for the earth ball and later stages of molten and hardened rock; but that is a story of a far removed past.[1] It reveals little they can be sure of concerning the earth now.

The question has been answered by taking as the mental starting point the physiographic location the children happen to be in at the time the discussion is held. Illustration has been facilitated by use of a clay ball, hard enough to be manageable but soft enough to allow a pencil or paint stick to be passed through its center and out. The clay ball represents the earth. A point has been designated on it to mark the spot which the children are occupying. They have been asked to think what probably lies immediately beneath the place where they are seated, whether this be the ground out-of-doors or the schoolroom floor; to let their thought, based upon their own experience and knowledge, travel downwards. It may go through soil or rock and possibly lines of pipe or cable if they are in the city; or through soil traversed by roots and insects and interspersed with stones, if they are in the country. In this progress underground some children have thought of water, or guessed that solid rock is encountered very far down.

---

[1] For differing opinions concerning this see: Sir James Jeans: The Universe Around Us. p. 11. Rollin T. Chamberlin in The Nature of the World and of Man. pp. 43-47.

Returning to the clay ball: they have been told that the actual knowledge of any person concerning the earth's interior extends for a distance much less, in proportion, than the relative thickness of an apple's skin to the apple itself. They have been shown with the clay ball that the merest dent is far too deep to represent this knowledge. They have been told that the deepest hole ever drilled into the earth penetrates to a distance of less than two of the approximate 4,000 miles which lie between the earth's surface and its center; that water has percolated to a possible depth of six miles.[2] They have imagined with the aid of a pencil or stick a journey straight through the earth to its center and out again on the other side, the tool in its course through the ball keeping pace with the information being given. The children have been told in each stage of progression the assumptions of science regarding the earth's interior composition.[3] A clear chart of a section through the earth, helpful at this point, is provided in The Earth and Its Rhythms.[4] They have been given the information, sometimes in response to questions, that volcanoes and earthquakes have helped scientists to establish their conjectures.[5] If the continents have been traced on the ball, and the tool enters in the region in which the children live, they have been interested to discover in what part of the ball's surface it emerges. That is, to discover what surface region, land or water, lies directly opposite their own.

---

[2] See Rollin D. Salisbury: Physiography. p. 84.

[3] See same. pp. 46, 47. Schuchert & Le Vene: The Earth and Its Rhythms. Chap. II. John J. Coulter: Elementary Science. Scribner's, 1917. Chap. VI.

[4] P. 15.

[5] See The Earth and Its Rhythms. Chaps. XVI, XVII and pp. 189, 190.

The topics of earthquake and volcano have been regarded as important enough for specific study. An earthquake can be thought of as a rhythmic phenomenon. It is defined as an undulating of the earth's surface caused by a sudden dislocation in the earth's crust, the shock of which is transmitted through the earth. Volcanic action, because intermittent, is in a sense rhythmic also; and the eruption is accompanied frequently with marked subsidence of the earth's crust. An example of fundamental interrelation is provided by the fact that the carbon dioxide contributed to the air in volcanic eruption is thought to be helpful to the continuance of the life of the earth's vegetation.

It has seemed worth while for children to make the discovery that nearly all our material wants are met with what the earth holds in the treasure house of its interior; that food, shelter, clothing, and the materials necessary to locomotion and construction all come from the inside of the earth directly or from animals or plants which have drawn sustenance from the earth. Children have been helped to realize this if they make a game of trying to touch, among the objects in a room, something which was neither taken out of the earth nor dependent upon something which came from it. Another game is that of stepping, played out-of-doors. The children take one step for each object or substance they think of which, it may reasonably be supposed, lies under the grass beneath their feet. The winner, of course, is the one who is able to take the greatest number of steps. Sometimes this game has started a zest for digging, just for the fun of seeing what may be found.

Another idea which has been arresting to children, is the concept that the earth's stores become known to man as he needs them or as he becomes capable of discovering them. The supply of coal was at hand for primitive man in his earliest stages, but he did not discover its use. The discovery and use of fuel oil and gas kept pace with later development. Germany has recently, in this dawning day of aviation, discovered a new alloy, duralumin, which combines the qualities of lightness and strength necessary to airplane construction. It is as strong as steel and nearly as light as aluminum. Helium, especially adapted to the dirigible's use, was not known in the earth in years long preceding the time when the Zeppelin came into being. This puts into consciousness the interesting idea of the unthought of possibilities of discovery in earth's stores in the day of future generations.

The outline which follows shows in a general way topics which have been considered, relative to a study of the earth's interior. As in all physiographic study, the local physical situation has decided to a great extent what topics could be profitably included or emphasized.

Soil: its origin

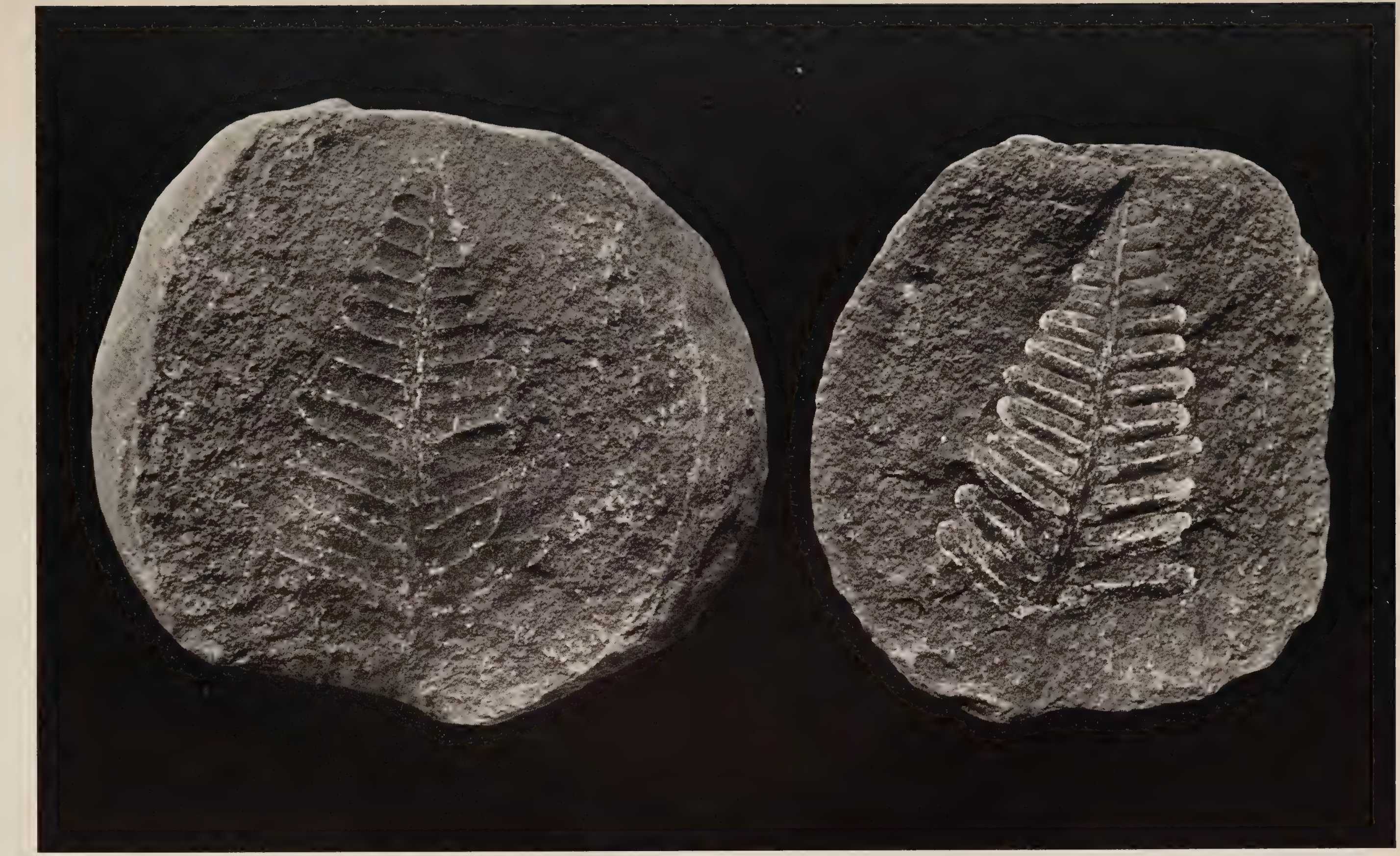
The mechanical composition of soil; analysis and comparison of soils of different localities

Plant growth, in relation to soil and ground-water

Seeds and roots

Earthworms and burrowing animals

Ground-water: its source and travels



Cornelia Clarke

BEAUTIFUL FOSSIL FERN FRONDS ARE FOUND IN ABUNDANCE IN STRIP COAL
MINES IN A SECTION OF ILLINOIS

Relation of ground-water to soil; to well, spring, geyser

Minerals: origin of igneous, sedimentary and metamorphic rock

Crystals, jewels, precious and useful minerals; fossils; neighborhood stones

Mines, quarries, oil and gas wells

Relation of ground-water to mineral desposits

Volcano and earthquake, and other phenomena of the earth's interior not included elsewhere

Soil

Children who have acquired information about the origin of the earth have a basis for understanding the history of the first appearance of soil.[6] This understanding necessarily involves some knowledge of the processes of weathering and erosion whereby, through the means of atmosphere, wind, water and other intersections, the wearing and breaking up of rock have taken place; but this whole matter is gone into with more thoroughness when the subject of the earth's surface has been reached. Into the early story of soil comes reference to the first low forms of plant and animal life, and the part their decayed forms played in helping to create soil which could support other forms of life.

It has been proved a good experience to let children make a simple, mechanical analysis of soil for the purpose of discovering its components of humus, gravel and clay. Interest has been stimulated, in the beginning of this experiment, by telling the children that they may hope to find that soil has three parts—but not telling them what these are or what they are like. The utensils and materials needed are a trowel, a wide-surfaced pan with a handle, a pitcher, a few square inches of window-screening, a sheet of white blotting paper, a magnifier, a soup strainer with a handle, three glass jars of uniform size and shape, and three gummed labels. If the experiment is carried on indoors, it is necessary to work at a sink; but the out-of-doors provides better opportunity for all of a group of children to see what is going on, and it takes care of water waste. In any case the experiment must be carried on near a water source.

---

[6] See Schuchert and Le Vene: The Earth and Its Rhythms. p. 21.

A small quantity of soil, perhaps two or three cupfuls, is dug, and placed in the pan. Water is then poured upon this, and almost immediately the children begin to see the lighter factors of soil—the leaf and bark fragments, the little sticks and stems, or insects—come floating to the surface. These are skimmed off with the screening as they appear and are placed on the blotting paper. When activity of this kind is almost stopped, the soil can be stirred slightly with a stick and, after its settling, the skimming process repeated. When the soil has yielded all it will easily of this plant and animal matter, the accumulations upon the blotter are looked at with the magnifier so that all can have a clear idea of the range of different substances which have appeared. These are then put into a glass jar, and labeled: Part I, Humus.

Next, additional water is poured into the pan of soil, and the whole is stirred thoroughly, and then allowed to settle for perhaps a minute. The muddy water on top of the settled soil is poured into another jar, and the label Part III is placed upon it. The children are told that about twenty-four hours will be required for this third part to reveal itself. Attention now goes back to the wet soil in the pan. It is turned into the strainer, and water is poured through it continuously until all that is soluble washes away and only stone fragments are left. This remnant goes into the remaining jar and is labeled: Part II, Gravel. Interest is extended by the use of the magnifier, as in the case of Part I.

The next day the children examine Part III and find there a fine smooth silt at the bottom of clear water. The water is poured off; and the children by handling some of this silt when it is partly dry discover that it can be modeled. The part remaining in the jar then receives its label, Clay; and when it has been left to dry, it begins to crack in a characteristic clay-like manner. The children are then told in response to their questioning, the values of each of these parts and the way in which soil is affected, for use, by an excess or a lack of any of them.

This description has presupposed that the soil experimented with has a normal constituency. The method used has served to show merely the kind of materials which make up the soil. By uniform procedure with a fixed quantity of soils obtained from different sources, the relative amounts of these materials have been brought out with a measure of accuracy.

For example, one group of children obtained "a cupful of best soil" from sixteen states and Canada and England. All these soils were analyzed by the children and the results kept in separate groups of labeled jars. The differing relative amounts of humus, gravel and clay in these soils and the wide color range proved most interesting and instructive. In this connection the children were interested to find out what the factors are which give to soils their color. In explaining this it was necessary to tell them that soil has a chemical as well as a mechanical composition; and they were told also that the scientist aids the farmer with knowledge of how to keep the chemical ingredients properly represented and balanced to promote plant growth.[7]

Interest in assembling clays of different colors has sometimes led children to model diminutive pottery shapes, and this has brought them naturally to an interest in primitive pottery in general. The experience of assembling soils from various localities has been made a reason for map use, map making and the learning of geographical locations.

Seeds and Roots

Childhood has time to get acquainted with seeds and thereby to make the discovery of one of creation's intriguing realms of variety and beauty in color, design, form and texture. The experience of playing with seeds from sheer artistic appreciation belongs surely to primary years where the capacity and the leisure to enjoy come together.

Anyone who does not know the bold patterns in black and white which sunflower and certain bean and melon seeds exhibit, who has not discovered the softly blended color tones of lentils or tried to see how many kinds and colors of ball shaped seeds he can find, has some pleasant diversions awaiting.

A few common seeds and grains—such as nasturtium and sunflower seeds, split and whole dried peas, from orange to buff, and from dark to palest green in color; corn, barley, rice and lentils—arranged and re-arranged on a ground of white paper can afford an experience not easily forgotten. Kaleidescopic geometric designs have grown out of this play, and forms resembling flowers. Seeds like rice, corn, barley, lentils, peas, when looked at through a tripod magnifier seem to turn as if by magic into beautiful exotic fruits; and the translucence of the rice and the corn enhances the beauty of the effect. An expedition into a field or a garden to gather seeds, or the blind purchase of a number of small packages of them, is also a profitable adventure. Surely it is worth while for anyone to stop in the busy round of living and look at seeds. It has been proved a good idea to let children make color drawings of certain seeds, to get still better acquainted by looking at them through a magnifier, and finally to plant them and wait for the wonder to happen.

---

[7] See Harold W. Fairbanks: The Conservation Reader. World Book Co., 1925. Chap. 9.

There is further opportunity for enjoyment when discovery is made of the setting of seeds in a design in the fruit or seed pod in which they develop. Cutting a ripe apple or a pomegranate in half at a right angle to the core displays one clearly defined figure; cutting a poppy capsule in half at a right angle to its stem displays another. The discoveries in seed arrangement are endless. To the average person few more beautiful experiences are likely to come than that of slowly opening a milk-weed pod at the stage of development when most of the seeds are pale green and blue in color, and only those at one end are beginning to turn brown. Children can see all of the process, first splitting the velvet-soft, gray-green pod along its natural opening and bringing to view the compact, dynamic arrangement of the beautifully shaped and tinted seeds with their closely compressed and nearly hidden white tails of satiny sheen. Then they watch the glistening satin as, dried by sun and air, it spreads fan-like, and becomes a silken fluff by means of which seed after seed sails off until all are gone. The departure of the seeds reveals at last the exquisite light green coloring and lacy structure of the lining of the abandoned pod—a fitting finale to the sequences of beauty this opening has revealed. Stalks of opened empty milkweed pods standing in the fields in the late fall can give added pleasure when thoroughly dried. The form then gains in interest by becoming sharper; the outside of the pod becomes rough and gray; the lining smooth and beautifully colored in gradations of orange.

The beauty of the released sailing seed of milk-weed is rivaled by that of the thistle, the cat-tail and other plants. But the globe of a blown dandelion, with its ethereal structure and its capacity for the play of light demands recognition for a beauty that is unique; fairylike. And when children have seen this beauty, have held the globe to the light to note its form and have blown off the seeds and watched them sail away in the sunshine like tiny parachutes, there still remains the interest of the dynamically symmetrical design which the plucked dandelion head reveals—especially when a magnifier is used. These whorls of seed scars, arranged in exact mathematical series, are a thought-evoking sight. They are discussed further in the chapter on Beauty and Rhythm.

Types of so-called seed houses and of traveling seeds, in their manifold varieties of adaptation to the primary purpose of propagation, offer of course a wide field of interest apart from the appearance of seed forms and their setting. It is a good field for children because they can so readily put into it first-hand research. Every fall provides, for suburban and country children, abundant illustration of seeds that sail, fly, stick, float or are thrown. It is fun, for instance, to place a witch hazel branch in the schoolroom in order to be surprised by the popping of the seeds when the right moment comes; to walk deliberately into a field of October weeds to see how many kinds of seeds one's clothes can accumulate; also to throw up handfuls of winged seeds of maple or alder and then watch them come spiraling down, or to get a similar result by shaking the tiny seeds from a pine cone. Texts are easily available which deal fully and appropriately with the whole subject of seed dispersal;[8] also illustrative lantern slides. The making of seed dispersal lantern slides is a profitable occupation for children.

It is of course the phenomenon of seed germination in the earth's soil that brings seeds into a discussion of the earth's interior. The crowning wonderfulness of any little seed is its potentiality. Shelley says:

> Let every seed that falls
> In silent eloquence unfold its store
> Of argument: infinity within,
> Infinity without, belie creation.

A seed seems almost sufficient illustration of infinity, eternity, principle, and cosmic order. For all that is learned of the universe seems to be, in one form or another, knowledge of sequences: "a continuous natural development in which antecedents pass over into their consequents."[9] It is a good experience for children to realize that in the middle of winter the live, tiny seeds lying buried beneath the surface of the ground are not asleep or inactive, but that step by step, steadily and gradually, they are evolving toward that appearance of continued life which spring will reveal. The following lines from Leigh Hunt have been helpful to children in bringing out this truth:

> Not a whisper tells
> Where our small seed dwells
> Nor is known the moment green

---

[8] See Grant Allen: The Story of the Plants. D. H. Appleton & Co., 1896.

[9] J. Arthur Thomson: The Bible of Nature. p. 71.

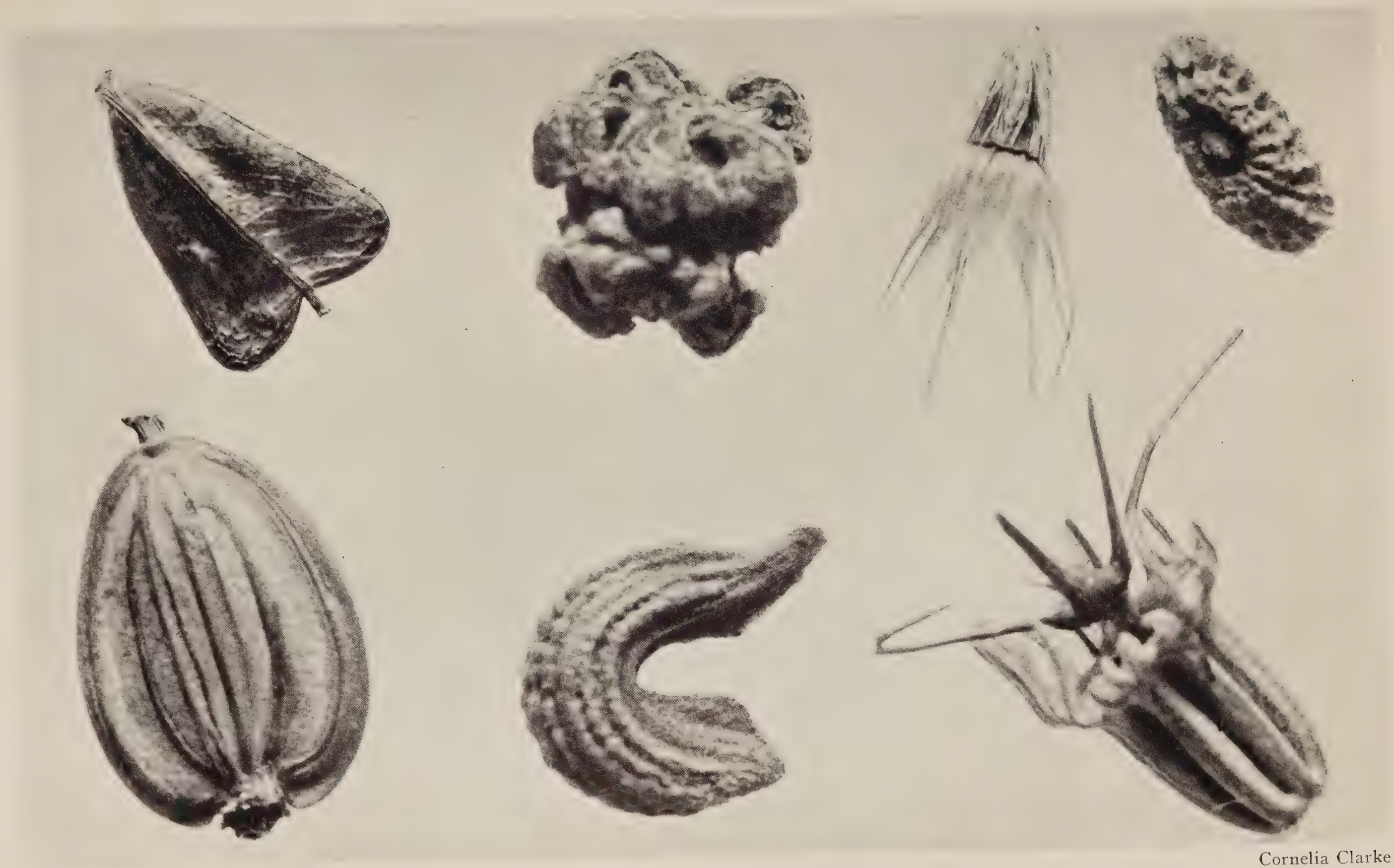
When our tip shall appear.
We thread the earth in silence,
In silence build our bowers,
And leaf by leaf in silence show
'Till we laugh atop, sweet flowers.

This poem, L. H. Bailey's description, How a Squash Plant Gets Out of the Seed,[10] and certain stereographs and lantern slides are good supplements to such direct experiences as planting a bean or other seed in water and watching its progressive development, investigating the steps of growth of weed seeds out in the field in the earliest days of spring, and in the same season pushing back the mantle of leaves in the woods to see the sprouting acorns. When gardening time arrives and seeds are to be put into the ground, the children have had unhurried opportunity to see them and to think about them and the marvel of their promise.

Children have sometimes been provided with seeds or bulbs of familiar flowering plants and, with these for suggestion, they have made series of little companion drawings in color: the seed or bulb, and the plant in blossom which they know will spring from it. The thoughts they are thinking while doing this are likely to be real ones. Cycles in plant growth also have been expressed by drawings in series. The seed cycle has presented its story in nine consecutive drawings placed side by side, each depicting the same plant in some one stage of its continuing development, as follows: (1) A brightly colored blooming plant, showing root, stem, leaf, bud and blossom. (2) The same plant with its flower centers enlarged and its gay petals blowing away in the wind. (3) The plant with flowers gone, turning dry and

---

[10] L. H. Bailey: First Lessons with Plants. Macmillan, 1898.



Cornelia Clarke

A GROUP OF COMMON GARDEN SEEDS. ENLARGED

brown. The ripened seeds flying from it. (4) A seed finding lodgment on the ground. Leaves fluttering down from the trees to cover it. (5) The seed lying slightly below the surface of the ground and beginning to swell and crack. (6) The seed showing signs of growth, with root tip and stem appearing. (7) The stem and budding leaves of a plant. The root fibers increased in number and size. (8) Stem, leaves, and buds of flowers. Stronger, longer roots. (9) A brightly colored, blooming plant, in color and kind like that pictured in the first drawing of this series. It is a story that might be entitled, Over and Over Again.

This experience, which can in so simple a way be brought to children, is essentially what Huxley describes in these words: "By insensible steps the plant builds itself up into a large and various fabric of root, stem, leaves, flowers, and fruit, every one molded within and without in accordance with an extremely complex, but, at the same time, minutely defined pattern. In each of these complicated structures, as in their smallest constituents, there is an immanent energy, which, in harmony with that resident in all the others, incessantly works towards the maintenance of its whole and efficient performance of the part it has to play in the economy of nature. But no sooner has the edifice, reared with such exact elaboration, attained completeness, than it begins to crumble. By degrees, the plant withers and disappears from view, leaving behind more or few apparently inert and simple bodies, just like the bean from which it sprang; and like it endowed with the potentiality of giving rise to a similar cycle of mainfestations." [11]

In considering types of roots and their ways underground many kinds of growing weeds have been examined.[12] And since the factor of preservation need not enter in regard to most weeds, whole small plants have been plucked in order that their form might be realized in its entirety. It is interesting to discover that common, negative looking plants, when seen root and all, may present an appearance of arresting symmetry, grace and linear effectiveness. If small enough to fit a blue print frame, lasting impressions can be made from these attractive, complete plant forms. And of deeper import than the visual impressions of form, structure, and functioning of roots is the meaning which Tennyson suggests:

---

[11] Thomas Henry Huxley: Evolution and Ethics.

> Flower in the crannied wall,
> I pluck you out of the crannies;
> I hold you here, root and all, in my hand
> Little flower—but if I could understand
> What you are, root and all, and all in all
> I should know what God and man is.

Trees provide, perhaps, the best means for studying roots with relation to the soil's part in plant nourishment; and they easily demonstrate the importance of roots to soil making, soil loosening and soil binding. The awakening of tree roots to activity in the spring has been described as follows: "Under the blanket of snow and the deep masses of leaves lie the eggs and cocoons of little insects which will rouse in the spring to feed upon the trees. Down there too are the wood ants and the mole deep in their long sleep, and the chipmunk napping in his burrow. Some flies and grubs are buried well beneath the surface soil. Further still are the tip ends of the tree roots, slowly absorbing water that they may be ready for business when the Frost King withdraws to his realms in the north. As spring draws near, the tree sleeps—soon the frost line begins to rise, the little rootlets are released from their prison and begin to stretch and grow eagerly. Long before the trunk and bark rouse to activity they are busily at work, storing every tiny cell with soil water. The warm days of early spring find them ready, and soon the sap begins to stir. Slowly and steadily through avenues long unused, it mounts upward and onward through the many cells to the very end of the twigs. . . . A few days of slow, bright, warm sunshine, and the buds swell and glow with color—everywhere is the joy of awakened life and the glory of the resurrection." [13]

---

[12] See Carlton C. Curtis: Nature and Development of Plants. Henry Holt & Co., 1916. pp. 46-70.

The whole story of the tree feeding, starting with the roots and returning to them and including the chemical change wrought through the agency of the leaves, is another of nature's cycles. The sequences of tree feeding have been illustrated for children by drawing, in coöperation with them, a tree in outline, including the roots, and making the passage routes between the parts show clearly. One color has been used to show the route of the ascending soil water, or crude sap, from root fibers to leaves. The sun has been put into the picture to call attention to the chemical change which sunlight aids in producing; and the starch-making process has been referred to in a general way. The route of the elaborated sap traveling downward and out to the parts has been shown in a different color. In order to understand this explanation children have needed some information concerning a tree's internal structure.

---

[13] Inez McFee: The Tree Book. Stokes, 1919. pp. 99-101.

Earthworms and Burrowing Animals

Digging into the soil here and there and turning it over has made children aware of earthworms and has led to knowledge of their work. Something of the importance of this may be realized if it is known that the estimate has been made that there may be 50,000 or 500,000 earthworms in an acre; and that they may pass ten tons of soil per acre through their bodies.[14] The advantage of this from the standpoint of vegetation is that they loosen the soil, making easier passage for the root fibers of plants and for ground-water, and they reduce mineral particles to a more useful form. They were in a sense "plowers before the plow"; and by burying leaves they contribute to the production of vegetable mold.

The burrowing animals too are closely associated with underground plant life for, like the earthworms, they help to loosen the soil. To these animals the underground provides warmth, shelter and sometimes food in the coldest part of winter. Their use of it John Burroughs has studied, and described with realism. In Squirrels and Other Fur Bearers [15] he tells of a weasel burrow which he and his son explored. Their procedure is set forth so definitely that children can draw a clear map of the whole plan of entrances, runways and rooms. Elsewhere he speaks of the underground life of foxes, woodchucks, chipmunks and meadow mice. He says:

"I have never been able to see clearly why the mother fox generally selects a burrow or hole in the open field except for better security. . . . The view being unobstructed from all sides, the young foxes are less liable to surprise and capture. . . . They are wont to come out on a warm day and play like puppies in front of the den. . . . On the slightest sound they disappear into the hole. Those who have watched the gambols of the young foxes speak of them as very amusing, even more arch and playful than those of kittens, while a spirit profoundly wise and cunning seems to look out of their young eyes." [16]

---

[14] See J. Arthur Thomson: The Bible of Nature, pp. 31-34.

[15] P. 75.

"The woodchuck usually burrows in a side hill. This enables him to guard against being drowned out, by making the termination of the hole higher than the entrance. He digs in slantingly for two or three feet, then makes a sharp upward turn and keeps nearly parallel with the surface for a distance of eight or ten feet farther according to the grade. Here he makes his nest and passes the winter, holing up in October or November and coming out in March or April. . . . Dig one out during hibernation and you find it a mere inanimate ball that suffers itself to be moved and rolled about without showing signs of awakening. But bring it in by the fire, and it presently unrolls and opens its eyes and crawls feebly about, and if left to itself will seek some dark hole or corner, roll itself up again and assume its former condition." [17]

"There is one thing that is peculiar about a chipmunk; he is never more than one jump from home. Make a dive at him anywhere and in he goes. He knows where his hole is, even when it is covered up with leaves." [18]

"The field or meadow mice doubtless welcome the snow. They can now come out of their dens in the ground or beneath the flat stones and lead a more active life. . . . The snow is their friend. It keeps off the cold and it shields them from enemy eyes—owls, hawks, foxes. They can venture abroad from their retreats without fear. They make little roadways and tunnels everywhere under the surface of the ground. . . . They can get at the roots of the grasses, or the various herbs and seeds they feed upon, as well as in the snowless seasons, and without exposure to enemies. I fancy they have fine times there beneath the drifts." [19]

---

[16] John Burroughs: Squirrels and Other Fur Bearers.
[17] Same, p. 36.
[18] Same, p. 30.

These quotations from Burroughs, and some from another author which follow, are made because in use they have demonstrated their ability to make the underground ways of animals real to children; and trips to the woods, subsequent to the reading of them, have meant aroused curiosity concerning every hole discoverable in ground or hillside, and speculation as to what has made it or would come out of it if one watched long enough.

Dallas Lore Sharp says of the jumping mouse and the possum: "Zapus the jumping mouse, the exquisite little fellow with the long tail and kangaroo legs, has made his nest of leaves and grass down in the ground, where he lies in a tiny ball just outside the frost's reach, fast asleep. He will be plowed out of bed next spring if his nest is in a field of corn or melons, for Zapus is sure to oversleep. He is a very sound sleeper. The bluebirds, robins and song sparrows will have been back for weeks, the fields will be turning green, and as for the flowers there will be a long procession of them started, before this pretty sleep-head rubs his eyes, uncurls himself and digs his way out to see the new spring morning." [20]

"By nature many [animals] are nocturnal through fear. Protected by the dark they creep out of their hiding places; they travel along the foot paths, they play in the wagon roads, they feed in the gardens . . . Many a hollow stump and uninteresting hole in the ground, tombs by day, give up their dead by night, and these wild things come forth. A long sniffling snout poked slowly out of a hollow chestnut, the glint of black beady eyes, the twitch of papery ears, then a heavy-bodied possum issues from the hole, clasping the edge with his tail, to gaze calmly about before lumbering off among the shadows." [21]

---

[19] John Burroughs: Squirrels and Other Fur Bearers. p. 115.

[20] Dallas Lore Sharp: A Watcher in the Woods. Century Co., 1912. p. 24. See also Enos Mills: Waiting in the Wilderness. Doubleday, Page & Co., 1921. p. 43.

I have never known children to listen to this latter description without wishing to dramatize it. In fact, consideration of woods animals underground or in other phases of their living, invites children irresistibly to spontaneous dramatic play. This is referred to in relation to woods experiences in the chapter which follows.

Ground-water

Children have dug into the ground to see how far down they find dampness. This can bring them to a realization of ground-water, and interest in knowing what its source is.[22] When they have learned that surface water arising from snow and rain is the source, they have been found ready to know something about the water's ways of penetrating the soil. They may of themselves discover that a loose type of soil takes up water more readily than a compact, clayey type; and they may think until corrected that all rock is impervious to water. Their assumptions have been followed by simple, illustrated statements of fact. The relation of ground-water to land-slides and the effects due to the freezing of water in surface rocks have been considered later, when the subject of the earth's surface is reached.

---

[21] Dallas Lore Sharp: A Watcher in the Woods. p. 197.

[22] Regarding the descent of ground-water and its movements, see Rollin D. Salisbury: Physiography. pp. 82-89.

The sources and possible travels and under-ground work of ground-water, have been made the subject of a pictorial chart drawn in conjunction with the children while conversation together is bringing out the story. To be clear and effective it has seemed necessary for such a chart to cover the space of a fairly large black-board, or to be drawn on paper of dimensions not less than forty-five by sixty inches. There is an advantage in using paper in that the chart can be preserved for future references. Details of the water's journey which have been pictured are the rain falling upon the ground, the roots of plants taking up soil water, a spring, a drilled well, a flowing underground stream, a cavern.

With this play beginning children have become ready for another and more intelligent chart of the passage of ground-water through soil and porous rock and rock crevasses, and its various modes of returning to the atmosphere. It has been pointed out that probably nearly all of the water which sinks beneath the surface comes up again sooner or later in some way.[23] It is interesting for children to know that ground-water, like surface water, finds passage to the sea. The making of the kind of chart referred to has been aided by diagrams which Salisbury's Physiography provides.[24] The text related to these diagrams contains clear, adequate description of the descent of ground-water, its movement due to gravity and other forces, and its typical phenomena.[25]

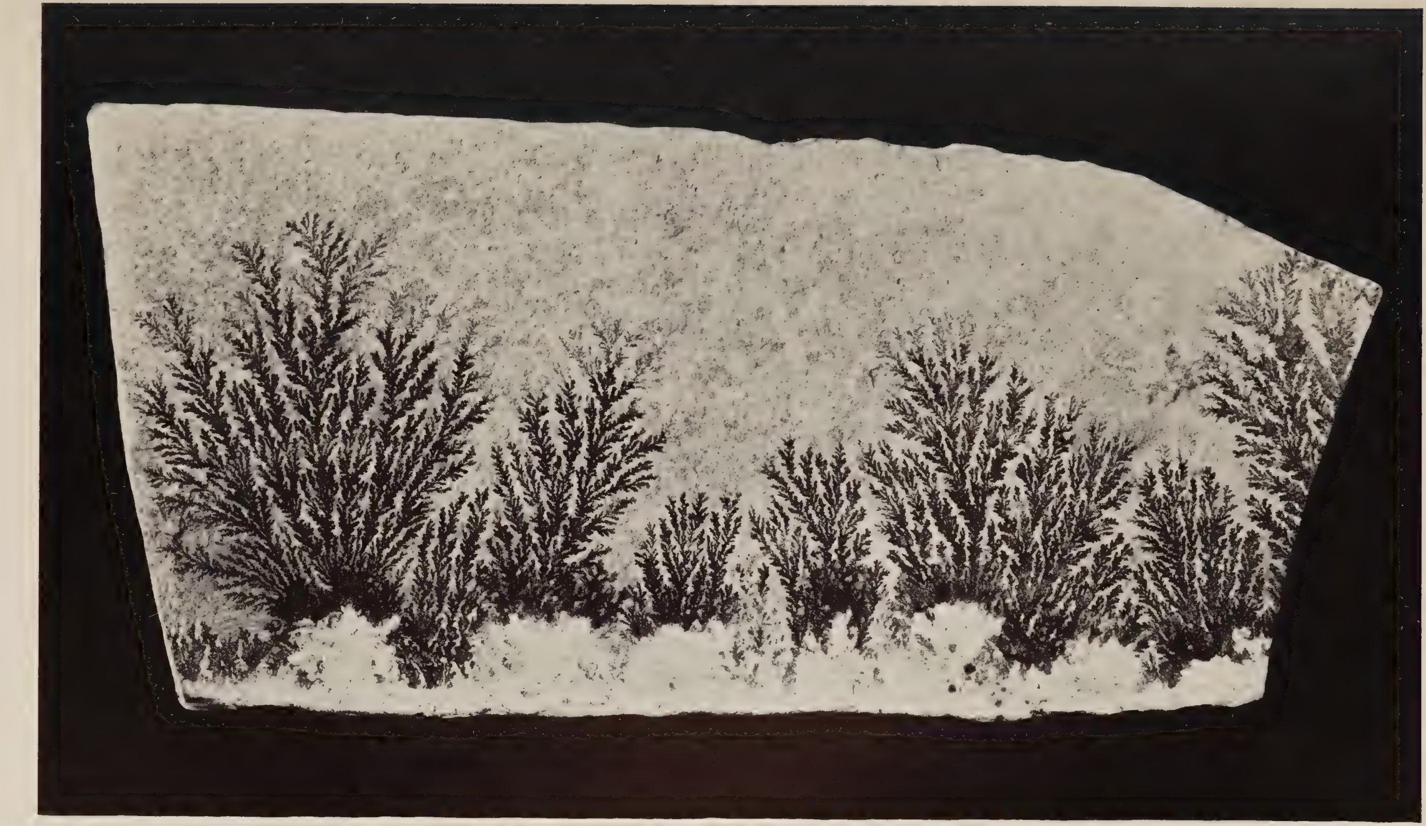
Children unfamiliar with the operation of a well have been taken to the country to see one when possible; also to see hill-side and rock springs. General discussion concerning the use of wells and springs has tended to bring out children's

---

[23] See Rollin D. Salisbury: Physiography. p. 88.

[24] Figs. 81, 85, 86.

[25] See also Schuchert & Le Vene: The Earth and Its Rhythms. pp. 168-170.



Smithsonian Institution, U. S. National Museum

PYROLUSITE IN SLATE SUGGESTS A TINY FOREST

interest in knowing the source of their own town's water supply. Because of its importance to study which follows, children have at this point been given some information concerning the chemical work of ground-water in its solution and deposition of mineral matter.[26] In the case of a group of children who lived in a region of mineral springs some of this knowledge was drawn from experience. As a rule children have not seen the ground-water's beautiful, rhythmically operating phenomenon, the geyser,[27] since geysers are found chiefly within restricted geographical areas of the earth. But certain moving picture travelogs show them; and for all school groups, some person is usually at hand who can give an eye witness's description.

Minerals

It has been my practice as teacher to leap into the world of crystals some free, propitious day without warning. Thus children have the joy of surprise when they first behold these mineral flowers of rare beauty in color and form and play of light. An assemblage of many colored single crystals and small clusters, displayed on white, or light neutral paper, has been shown them. Small pieces are best, in exhibiting a group of crystals. They play into each other's coloring as larger ones do not and they permit a variety of forms to be seen together. Thus enjoyment is increased, comparison is stimulated, and discovery of facts is promoted.

Clear, colorless, little columns of gypsum radiating in every direction from a common center, crystals of purple amethyst in flat cluster, rose pink rhodochrocite, silvery interlocked cubes of galena, blue-green amazon stone, soft yellow sulphur, a dark garnet so many sided as to seem rounded, coral colored needles of crocoite, transparent obelisks and pyramids of quartz shooting in varying sizes from a common base, darkest blue azurite, a column of translucent tourmaline with its deeper pink paling and merging into delicate green—these and many others with equal claims are worthy of a child's first viewing. The beauty of them, spread out together, is enough to make anyone exclaim or be silent according to his nature.

---

[26] See Rollin D. Salisbury: Physiography. pp. 96-105.

[27] See Schuchert & Le Vene: The Earth and Its Rhythms. Chap. XVIII.

Crystals like these, as well as other attractive or interesting small mineral pieces, can be obtained easily at slight expense. Those sent from the Ward Natural Science Establishment in Rochester come with information as to their identity and their regional source.

Here in the field of crystals, if anywhere, in dealing with children, has the precept "go slowly" been heeded. What does it matter if for several successive days children merely revel in this new found delight? What if they are engaged for hours merely in arranging and re-grouping in experimental ways to bring out new satisfaction in color and color contrasts? They have sometimes made a game of creating a variety of color groupings of just a few crystals, three or five perhaps. Texture and effect of light as well as color enter into the pleasure of selection.

The cultivation of love of the beautiful is something so much valued in the curricula of education generally, especially in secondary and higher education, that a considerable proportion of pupils' time and thought may be deliberately assigned to courses in art as the means to that end. Therefore, when the appreciation and expression of beauty come spontaneously, as they are sure to do in connection with crystals, why not let them have real freedom? And undoubtedly children's absorption in esthetic aspects will bring out some factors of intelligent observation and inquiry. This is referred to later in this chapter.

Whatever play children engage in with crystals, interest in form is bound to be aroused. They come to know unmistakably the variations and the range of forms which their own collection exhibits. Widely separated in color are smoky, clear and purple quartz; but specific characteristics of form, children discover, are exhibited by all the quartz crystals of whatever color. Of their own volition children begin to count crystal faces, to liken crystals to other geometrical shapes known to them in previous experience, and to compare the forms of crystals of different minerals. They have discovered that the crystals in a single cluster vary in completeness, size and coloring; but that the complete crystals do not vary in basic shape or in the number of their faces. They may observe too certain factors which, for any specimens they possess of a given mineral, seem to be constant.

But if little children are to learn that all crystals of a given mineral can be reduced to a common type or fundamental form, they will have to get the knowledge by statement rather than by their own discovery or observation. For while there are only seven basic crystal systems and all minerals are believed to conform to one of them, there are within these systems hundreds of form variations. Scientific supply houses and museums possess models of all these forms; but because of their great number and the difficulty experienced in the understanding of their form principles they are not material for little children.

In order to understand crystals at all, children must be taught that the internal structure corresponds to the external form. Until this fact is clearly apprehended, the full wonderfulness of a crystal cannot be realized; apart from this fact the crystal could have no more interest than a cut or molded shape. John Ruskin invented a game for imparting this knowledge to children. In this game the children represent atoms. At the call "Atoms, to your places!" the children run to predetermined spots, and an orderly formation appears. The detail of this description will be found in Ethics of the Dust.[28]

If snow crystals have been experienced by the children of a group, these have been made the start of an explanation of mineral crystallization. But if they have not, it has seemed best at this point not to introduce them but to proceed with the children to an experience of making some crystals—of salt, alum and sugar. No confusion results from including the sugar if it is pointed out that sugar is not mineral, but that the phenomenon of crystallization can take place outside the mineral kingdom. These three kinds of crystals are selected because they are likely to bring good results easily and because they illustrate different forms; the salt appears in cubes, the alum in octahedra, and the sugar in "tabular forms of rectangular outline." [29]

To produce the crystals, as much of these substances is added to boiling water as will dissolve in it readily. The concentrated solution is then poured into a saucer. As it cools, some of the material separates out into crystals. If a thread has been placed across the saucer in advance some of the crystals will adhere to it. If these, suspended by the thread, are held in a concentrated solution of the same substance, they become larger and better formed. Crystals made in this way are convenient for observation if kept in groups of their kind on glass slides and placed on a window-sill or in some other location where direct light can reach them. To bring out a clear view of their form the use of a magnifier has been found helpful. It is to be realized that these experiments cannot explain what the process of crystallization is, but they afford to children visible proof that crystallization does take place.[30]

---

[28] Wiley and Sons. p. 53.

[29] L. J. Spencer: The World's Minerals. p. 7.

Jewels, children have learned, are usually crystals or parts of crystals cut into standard or other shapes to enhance their color and lighting. In trying to acquaint children with the characteristic cuts and colors of certain jewels, I have not hesitated to excavate the glass stones from five-and-ten-cent-store rings and brooches. It is only necessary that children should know that what they are seeing, in these instances, is representative. I can find much beauty in these clear, colored, light-flashing, gleaming bits of glass—ruby red, diamond sparkling, sapphire blue, amethyst purple, clear emerald green or aquamarine, and topaz yellow—especially if their groupings be played with on a ground of white. This intimate experience with make-believe jewels has been followed by some observation of real ones. For among the parents and friends of a group examples of all the familiar gems and their cuts can probably be found. The still, calm beauty of moonstone and the elusive color charm of fire opal have not been overlooked. A little poem which children who have played with a fire opal invariably enjoy is the following:

My mother has an opal ring,
A dainty, softly glowing thing
Which like a rainbow seems.

---

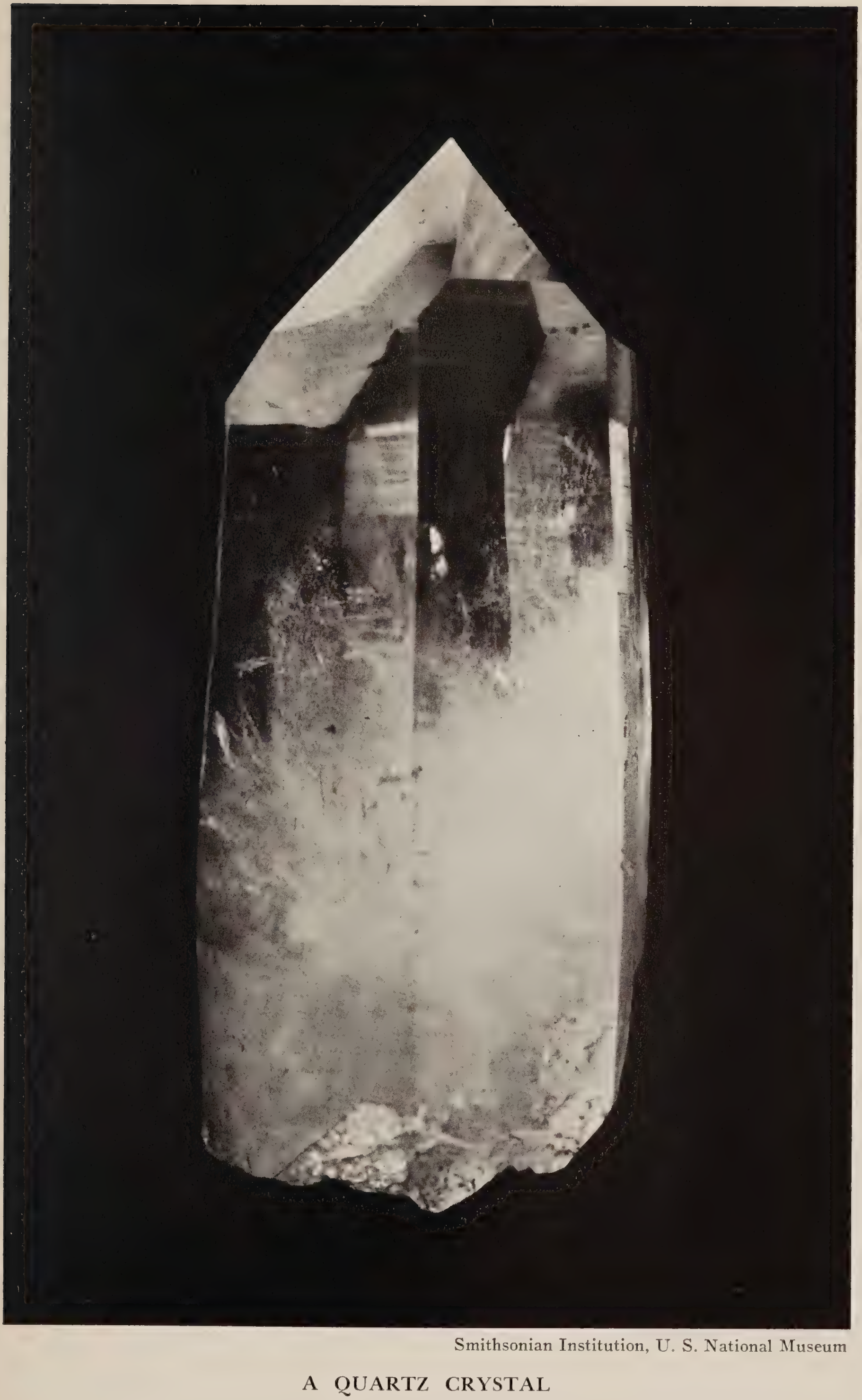
[30] See L. J. Spencer: The World's Minerals. pp. 6, 7.

It flashes red, then green, then blue,
Its colors are of every hue;
The lovely jewel gleams upon her finger. When the sun
Has gone to bed and day is done,
My mother's ring I wear,
And watch the firelight make it shine
As if a bit of sunset fine
Had been imprisoned there.

It is worth while, too, to consider the variety and beauty of the settings in which jewels may appear; also the attractiveness which some so-called semi-precious stones may have.

When children have passed a number of days in experiencing crystals and jewels they have been found ready for what usually constitutes a further surprise—the generally unheralded beauty of other minerals, some of them crystalline but not in recognizable form. As in the case of crystals, white or neutral paper has been used as a setting. The stones displayed have been perhaps small pieces of rose quartz, azurite and malachite in combination and in concentric waves of sky blue and spring green, soft yellow carnotite, henna colored hematite, pale pink or white satin spar, keenest blue-green chrysocolla, gray labradorite with its purple and blue diffraction, moss agate with its dark fern-like tracery in a ground of milky whiteness.

Again, as with crystals, children have given themselves up to the utter beauty of what they are seeing. They have imagined cities built of these beautiful stones, and they have turned to the crystals to provide forms for their cities' envisioned minarets and towers. These are concepts which find a parallel in flashes of description in some of Dunsany's world-of-magic stories. Children have sometimes tried out



Smithsonian Institution, U. S. National Museum

A QUARTZ CRYSTAL

their architectural ideas, building with the stones jewel-studded castles, towers, gateways, walls and bridges.

There is another possible surprise in the revelations which small tripod magnifiers produce. Azurite and malachite show small nodules unguessed before. A merely rough surface of gleaming pyrite becomes well defined in cubes. A small, seemingly undifferentiated disk of pale green wavellite turns into a well organized flower-like structure, the tiny crystal needles looking like slim petals attached to a center. The fern seen in the moss agate grows in clearness and delicacy.

Then, another discovery. If the fine dust-like particles and tiny fragments which have fallen from the stones while they were being handled be gathered together under the magnifier, they look like a gay and rarely beautiful assemblage of little jewels, varied in color and sparkling with light. Stone dust of this sort becomes a treasured possession. Again—and this is a discovery children have not failed to make—if larger pieces of the rougher stones such as azurite, malachite, hemalite, granite, and standstone, loosely piled, are looked at through the magnifier the beholder is transported into a region of wildness and natural grandeur; of rough gorgeousness of color combined with green mossy softness. He looks across vast, rugged, glory-colored canyons, down jagged mountain steeps, through crevasses of piled up bowlders, or into deep, cool caverns that might be under the sea.

In their play with stones children more or less unconsciously learn something of composition, structure, texture, fracture, and of other types of cleavage; of striation, and of surface effects which wind and water may have produced; of relative weight, hardness, frangibility, and transmission of light.[31] Making paintings of stones, especially if water colors be used, has provided a satisfying means of becoming more intimate with them. In paintings of crystals, crystal gems in their matrix, and cut gems, adults are sometimes surprised to see the subtle appreciation children evidence in producing colors and gradations of tone. This is true also of their representation of textures and of effects produced by light, whether iridescence, luminousness, shine, luster, transparency or translucence; also of their drawing of form.

---

[31] See L. J. Spencer: The World's Minerals.

Through such intimate contact and observation children have become ready to hear of the great classifications of rock on the basis of origin—igneous, sedimentary, metamorphic—and to learn their characteristics in so far as they are easily discernible.[32] Concrete illustrations of these classes have been provided in the first place; but as soon as the children have grasped the ideas presented they have brought to the classroom some illustrations of their own finding.

Following this experience has come information of ore veins, pockets, outcrop, and of mines and quarries.[33] Because they are derived from coal, which seems like a mineral, and because they are important factors of the supply of humanly useful natural resources which the earth's interior contains, oil and gas wells make a claim for attention.[34] When experience of mine, quarry and well could not be first hand, it has been found helpful to provide accounts by eye-witnesses, to use stereographs, to go to see models in a museum or elsewhere, and to let the children dramatize or construct from clay or plasteline illustrations of essential features. With sufficient knowledge as background, a local mine, a quarry, a gravel pit, tunnel-digging or other excavating, becomes a mecca of unfolding rewards. Playing at being miners becomes for a time a favorite occupation.

---

[32] See Rollin D. Salisbury: Physiography. pp. 47-53. Schuchert & Le Vene: The Earth and Its Rhythms. pp. 16, 17.

[33] See The Earth and Its Rhythms. Chap. VIII.

[34] See same, Chap. IX.

Once launched in interest in their neighborhood stones children do not know any bounds. They may stagger into the schoolroom with great pieces of rock of unbelievable weight; and they fill window-sills and all other available spaces with a multitude of stones of seeming similarity, but known to each finder for some special feature of beauty or geologic meaning. This interest in common stones has given play to the most discerning traits which children manifest in this work. The beauty of coloring which they may point out in a little slab of shale or ash or chunk of sandstone is really there; it needs only eyes that see to bring it out. The fascination of breaking stones open in the hope of discovering that one has a geode or fossil or merely to enjoy the intensified color of the inside, of separating scale after scale of mica, of tapping slate to see it break into leaves in endless repetition in accordance with the physical law that governs it, of striking sparks by the impact of stones, or of using the scratch test to determine relative hardness, is worth even grown-up absorption.

The play which imagination has in seeing pictorial representations in the surface irregularities and colors of stones—a range of mountains, waves of the sea, the moon and clouds—is a good avocation for eight years old, and perhaps for any number of years older. An occasional stone, perhaps a conglomerate or jasper, sent off to a lapidary for polishing comes back to provide a new pleasure. Some children are fortunate in living in a locality in which petrified wood or fossils are sometimes found. None should miss seeing the beauty of a leaf or shell imprint or learning about the natural process which caused it. Any mineral supply house can provide these specimens. Many children are within reach of a sea or lake shore where they can have the joy of gathering little pebbles, marked or formed by the water, the varied colors made more intense by their wetness and perhaps by a setting of white sand.

It is worth while to remember that the different localities in which children of various school groups live offer different natural resources; what is common in one place is not found at all somewhere else. It is possible to build up an interesting system of exchange between groups of children, through some person known to both groups or through a school or an organization. This procedure has a social value in addition to its primary purpose.

Attractive photographic representations of minerals, in color and otherwise, are to be found in a number of books; among them Gems and Gem Minerals,[35] now out of print but obtainable in libraries; A Book of Precious Stones,[36] The World's Minerals[37] and The Outline of Science.[38] Parts of the text of these books are written simply enough for children who have some background of experience to understand them. A set of illustrations in color, of value because of the classifications and groupings they show, can be obtained from the Perry Pictures Company.

If the children have been within reach of a museum which has a stones collection, they have been taken to see it, but not until they have had a long, intimate experience with stones which they could handle freely and about which they have learned much. With this preparation they are likely to read life and realness into the glass-shielded, labeled

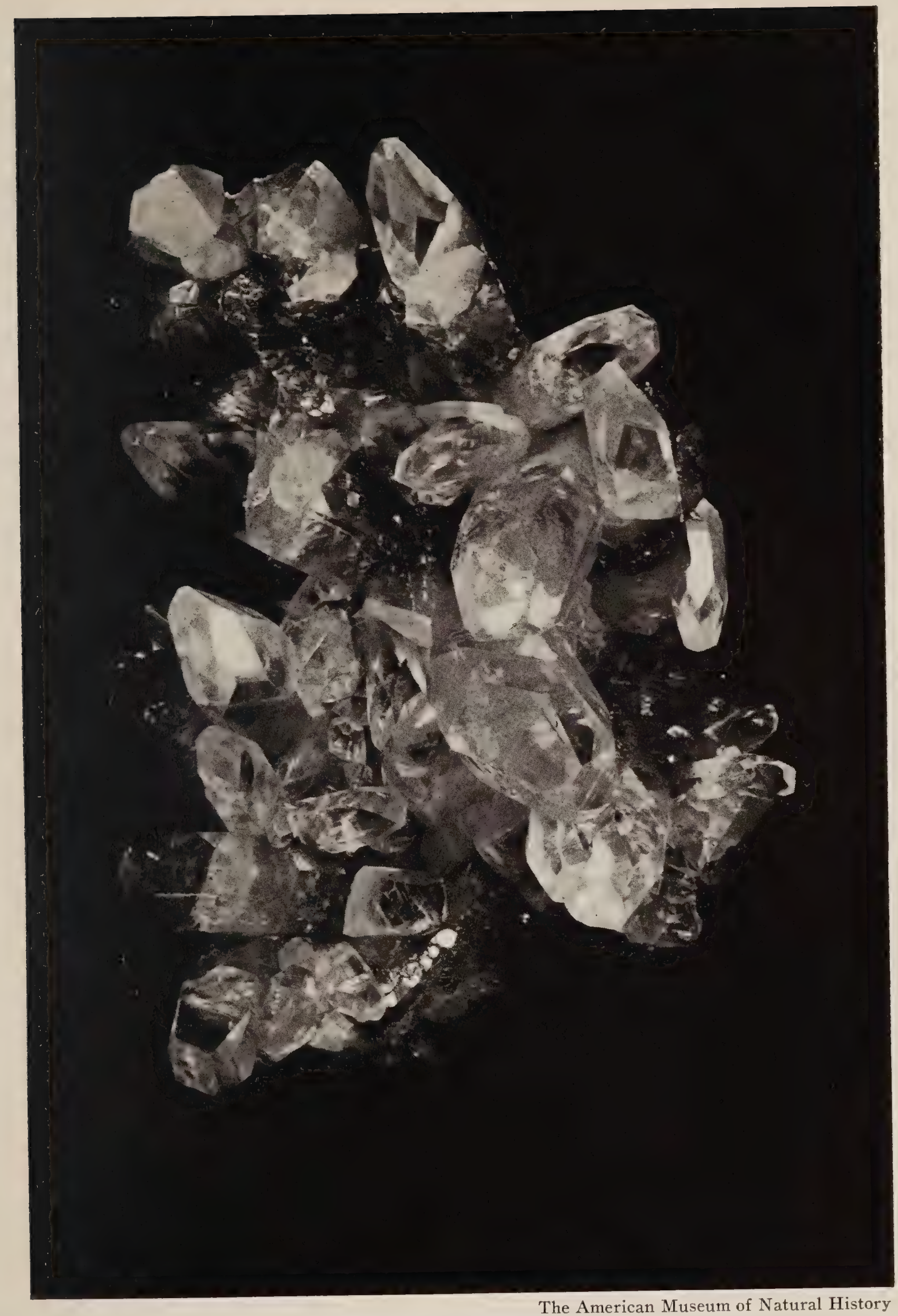
---

[35] Oliver Cummings Farrington. A. W. Mumford, 1903.

[36] Julius Wodiska. Putnam's, 1909.

[37] L. J. Spencer. Stokes, 1916.

[38] J. Arthur Thomson. vol. IV



The American Museum of Natural History

CALCITE CRYSTALS

museum rows, and to get from them something profitable, beautiful and exceedingly wonderful which in a measure they understand.

The principal known mineral resources of the whole earth and the regions of the earth's crust in which they are found have been made graphic by preparing a wall map in outline, as large a map as space allows. This has been worked out in hemispheres in order to keep before the children the idea of the whole round world. The ocean and larger lake parts have been painted blue; the continents and larger islands have been covered with light buff plasteline and the more important mountain and river system indicated by relief and line, respectively. Most children of approximately eight years of age have needed at this point to get acquainted with continents and oceans, their shapes and their names. So far as possible the travel experience of members of the group or their families has been identified with these bodies of land and water; and all these regions have been associated in consciousness with reference to the location of the children's own continent, country and town. Working from a supplied chart of information the children have imbedded in the plasteline in specified regions small bits of the minerals found there. So far as possible these have been actual; but in the case of jewels, glass has had to suffice.

The finished result is a clear showing up of especially productive localities such as a section of India, the coast range through the two Americas, and parts of the Alps and the Ural Mountains; also it reveals the occurrence of the same mineral in widely separated regions. If the children have learned how large a part seeming accident has played in the discovery and consequent opening up of the earth's buried treasures to date, the thought of further possibilities of discovery is likely to occur to them. As they look over their map this thought may impress them with the vivid force of romance, or it may provide deeper connotations of supply available for needs. A map of this kind carefully made has some value just as an achievement in beauty; and it is an effective teacher of regional geography. Moreover it is a factor in making children feel the oneness of their world.

The study of the inside of the earth, with its endless concrete possibilities, makes a special demand upon the teacher to be careful to refrain from including too much. Children are more likely to gain fundamental concepts if their experience is kept uncrowded and unhurried. It should be remembered that the illustrations recounted here are drawn from a nine years' span of teaching, and several groups of children.

The subject of the inside of the earth, like the subject of the earth and its companions in space, brings children into the presence of ideas of order, rhythm, beauty. In both fields of research the principles of gravitational force and cyclic or sequential change are found to be operating. There is seeming difference in the media of expression; yet the rock of the earth's interior is but a further development of the sun and planet sequence. In the study of the inside of the earth, the idea of potentiality comes out with arresting force. The earth's crust illustrates it, as already pointed out, in that it seems to hold within itself adequate supplies to meet man's growing or changing needs; and plant growth illustrates it also, with its factors of absorption, assimilation, development, and reproduction. Closely associated is the idea of conservation, whereby activity can bring change without loss. From tin plate, derived from ore taken from the ground, a tin can is produced. The can serves the purpose which it was made to serve and is then thrown out. Exposed to the air slow oxidation sets in and in time the can, except that part of it which the atmosphere claims, crumbles back into the soil from which it came. A tree is uprooted, it withers, "dies" as we say, and is burned. The tree, as such, no longer exists. But every particle of it is continuing in some form; and much of it could be identified and measured or weighed under requisite conditions of scientific observation.

In such instances nature seems to say there is no death, in the sense of attaining non-existence; no cessation from activity. There is rather progressive change, though sometimes involving what seems like radical transformation. Walt Whitman says:

> Nothing is ever really lost, or can be lost,
> No birth, identity, form—no object of the world,
> Nor life, nor force, nor any visible thing.

V.

The Earth's Surface

"I HAVE heard of a wonderful ball. It is so large that trees can grow on it; so large that cattle can graze, and wild beasts roam, upon it; so large that men and women can live on it, and little children too. In some places it is soft and green, like the long meadow between the hills where the grass was so high last summer; in some parts it is covered with tall and thick forests, where you might wander like the babes in the wood, nor ever find your way out; then again, it is steep and rough, covered with great hills so high that when you look up ever so far you can't see the tops of them; but in some parts there are no hills at all, and quiet little ponds of blue water where the white water lilies grow, and silvery fishes play among their long stems.

"Now, if we look on another side of the ball, we shall see no ponds, but something very dreary. A great plain of sand—sand like that of the seashore, only here there is no sea—and the sand stretches away farther than you can see, on every side; there are no trees, and the sunshine beats down, almost burning whatever is beneath it. Look at one more side of my ball as it turns around. Jack Frost must have spent all his longest winter nights here, for see what a palace of ice he has built for himself. Brave men have gone to these lonely places to come back and tell us about them; doesn't it look cold, the clear blue ice, almost as blue as the air? And look at the snow, drifts upon drifts, and the air filled with feathery flakes. Now what do you think of my ball, so white and cold, so soft and green, so quiet and blue, so dreary and rough, as it floats along in the air with the flock of white clouds around it?"[1] This, in paraphrase, is one writer's way of presenting to children a general view of the earth ball's surface contrasts.

When a group of children have attained the age of eight or nine it is almost certain that all of them have been local travelers at least, and some may have journeyed long distances. In the presence of a terrestrial globe a group as a whole is usually able to contribute a fair amount of general knowledge concerning it. With tiny models of trains, steamships and other means of transportation the children have, with help, demonstrated routes to this point and that which some of the group had heard of or traveled to. Selected lines from the poem Salut au Monde have added to such impressions.

What do you see, Walt Whitman?
Who are they, you salute, and that one after another salute you?

I see plenteous waters;
I see mountain peaks . . .
I see the vast deserts of western America,
I see the Libyan, Arabian and Asiatic deserts;
I see huge, dreadful Arctic and Antarctic icebergs;
I see the superior oceans and the inferior ones . . .
I see the long river stripes of the earth . . .
I see little and large sea dots, some inhabited, some uninhabited . . .
I see the regions of snow and ice . . .
I see the cliffs, glaciers, torrents, valleys of Switzerland—I mark the long winters and the isolation.
I see the cities of the earth,

---

[1] Jane Andrews: Seven Little Sisters. Ginn & Co., 1924. pp. 1-4.

I see ranks, colors, barbarisms, civilizations—I go among
them indiscriminately,
And I salute all the inhabitants of the earth.

A long distance motor or train ride has taken on new meaning for children when they see it as providing an unfolding panorama of the surface features of their world; and merely watching a fast moving train has, through imagination, done much the same thing.

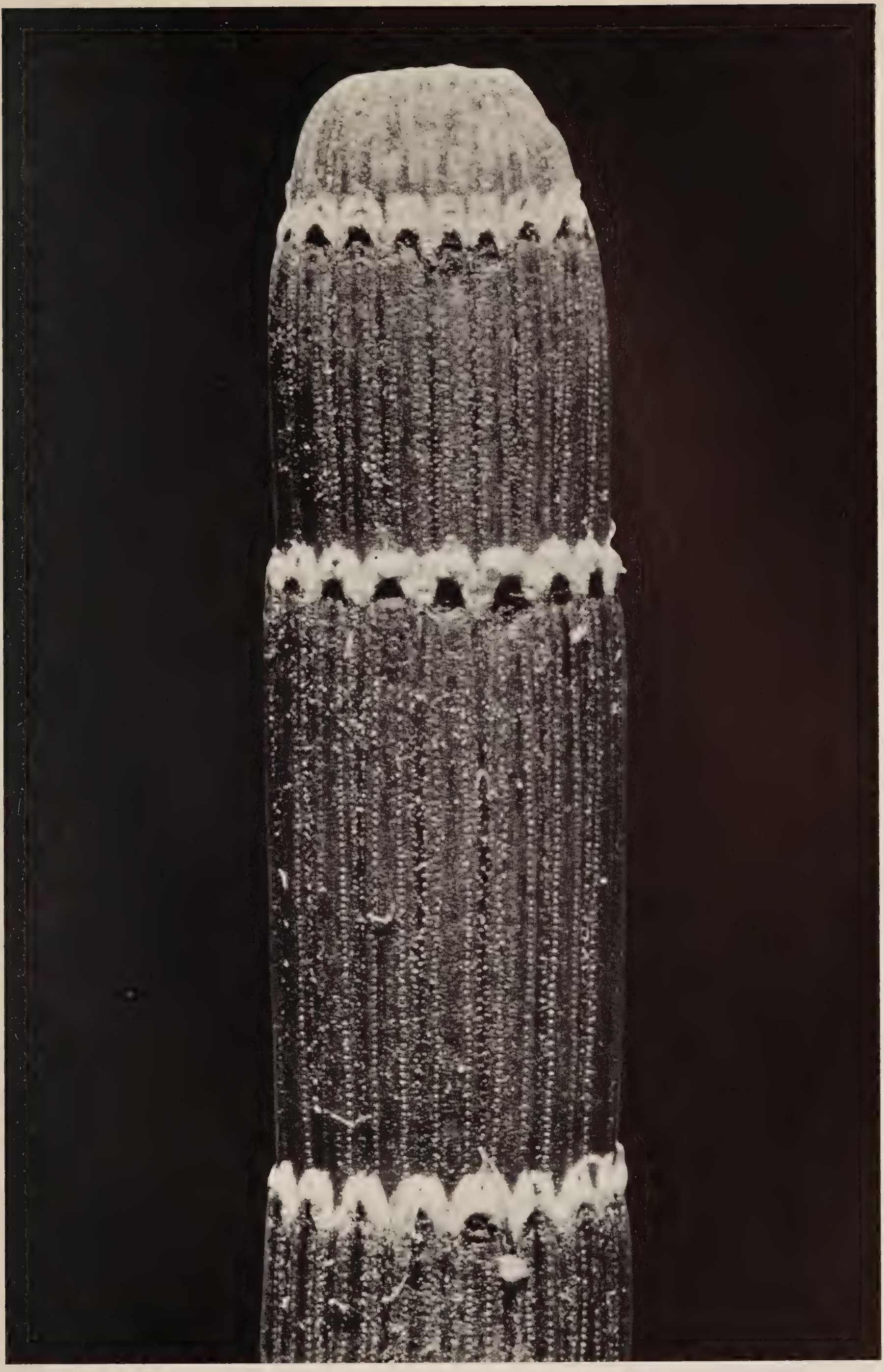
In the evening from my window
Just before I go to bed
I can watch the trains agliding
Beneath the stars that shine o'erhead.
Far away, the engine seems a beetle black
Drawing lines of glowing fireflies on a track.

How I wonder where they are going,
What they will see before the day,
Mighty mountains, lonely forests,
Sleeping cities far away.
Arching bridges, long, long trestles they'll pass o'er
Plunging into darksome tunnels with a roar.

In these days of flying, it is sometimes possible to find an aviator who will give the children of a group an idea of the earth as he sees it spread forth on his journeys through the sky. This view from above can be gained, in imagination, from Selma Lagerlöf's story of Nils' flight on the back of the gander;[2] from the experience of the Thief of Bagdad or the Little Lame Prince on a piece of magic carpet; or from the story of the little boy in Rumpty Dudgett's Tower. The same idea comes out in the following stanzas which children love, partly because of their repetition and rhythm:

---

[2] The Wonderful Adventures of Nils. Doubleday, Page & Co., 1926. p. 30.



Cornelia Clarke

HORSETAIL, ARCHITECTURAL IN ITS SUGGESTION. A RUSH-LIKE PLANT FOUND COMMONLY ON ROADSIDES. ENLARGED THIRTEEN DIAMETERS

Silver moon sailing
Through the sky sailing
What do you see when you look down below?
Snow covered mountains,
Palaces, fountains,
Turned into silver beneath your clear light.
Silver moon sailing
Through the sky sailing
What do you see when you look down below?

Cities and towers,
Gardens of flowers,
Turned into silver beneath your clear light;
Ships on the ocean,
Windmills in motion,
Cities and towers,
Gardens of flowers,
Turned into silver beneath your clear light.

An interesting and instructive occupation is provided in a game whereby children can envision the earth's surface as continuous even though varied. They have looked successively, east, west, north and south from the place where at the time they were sitting; and this by pre-arrangement was out-of-doors. They have told for each of these directions what lies within the range of their sight, and immediately beyond it as far as their knowledge goes. Then, with the aid of imparted information, they have pushed back the mental boundary, west and farther west, when that is the direction in which they are looking. The attempt has been made to make real to them the oceans and countries they looked toward. While their physical sight rested on the actual horizon, their mental gaze traveled on and on until it reached to islands of the Pacific, looking west; across Europe, looking east; to arctic and antarctic regions when looking in the other directions. Then with the help of the globe the children have traced the routes thus begun all the way around the world, until the place where they were sitting, the original starting point, was recovered.

If this mental journeying is to be realized it has to be a living experience. It must know acres of grain waved by the wind, mountains that are hard to climb but with summit views that reward the struggle, cities that clang with traffic, oceans that surge and roll, and foreign lands that arrest with uncommon sights and sounds.[3] A familiar children's poem can help to build this vision:

Great, wide, beautiful, wonderful World
With the wonderful water round you curled
And the wonderful grasses upon your breast,
World, you are beautifully dressed.

You friendly Earth, how far do you go
With the wheat-fields that nod and the rivers that flow,
With cities and gardens and cliffs and isles
And the people upon you for thousands of miles?

All these ways of setting forth the surface of the earth have been referred to because I believe a panoramic view is important in the beginning of earth surface study in order to establish the sense that the whole round world is being worked with and that the people of the earth are fundamentally one; also to awaken children to realization of the great variety and beauty which the earth's surface as a whole illustrates.

The regions of the earth are more effectively bound together in children's consciousness if the children are taught early something of latitude and longitude. Those who have studied the earth in space have already learned the reason for cold climate at the poles and hot climate at the equator throughout the seasons of a year. Children at this point of knowledge have traced on a globe equatorial and polar circles, discovering thus what countries have these climatic extremes. Next, they have traced circles north and south of the equator and midway between it and the polar circles. When their reason has conjectured the climate of regions which these mid circles pass through, they have traced the circles around the globe again, this time noting first in the northern and then in the southern hemisphere all the countries which in common enjoy the temperateness which this median position insures. They have then been interested to find their own country lying on the northern circle.

---

[3] See description of North American Continent by Edward Yeomans: Shackled Youth. Little, Brown & Co., 1921. p. 24.

Next they were told that these are called circles, or parallels, of latitude. The system of numbering was explained to them; and by tracing other circles they grouped the countries and oceans of the whole world on the basis of their climate. Meridians of longitude were shown first as a mere device for finding map locations. The request, "Find the country which is located on the map where the fortieth parallel of latitude north and the ninetieth meridian of longitude west come together," illustrates the kind of geography game which children at this point have played with each other. From this map game experience, children have passed easily into some awareness of the practical value of latitude and longitude reading devices in aerial and sea navigation. They have also been told, and usually in answer to their questioning, that the placement of the zero meridian of longitude had to be arbitrary; and they have found for themselves its location on the map, at Greenwich. In the drawing of maps of the world, in hemispheres, children are greatly helped to get the locations and proportions of continents correct if they have in advance drawn the latitude and longitude circles.

The study of the surface features of the earth, and related topics, has in general been organized somewhat as follows:

Panoramic concept of the earth as a whole

Latitude and longitude

Rocks, glaciers   The rock and glacier cycles

Mountains, hills   Fold, residual, and accumulation origins   The mountain cycle   Principal mountain systems of the world

Plains, plateaus: their origin   Subsidence and reëlevation   Principal plateau regions of the world

Deserts, dunes   Sand movements

Rivers: sources, travels, work   Principal river systems of the world

Oceans: origin, depth   Movements of wave, tide, current

These topics cover physical states of the earth's crust and the principal examples of traversing and accumulated water. A book which can be used helpfully with all of them is The Earth and Its Rhythms by Schuchert and LeVene. But the visualized earth is bound to include in its picture vegetation and animal life; also distinguishing local conditions, such as farm land, field and meadow, woods, forest and jungle, or bare regions of ice and snow. Not all of these topics can be considered intensively in one year, in the work of little children. My own selections, for real experience lived with and appropriated, have been usually woods and woods life, rocks and mountains, rivers and the sea.

The Woods

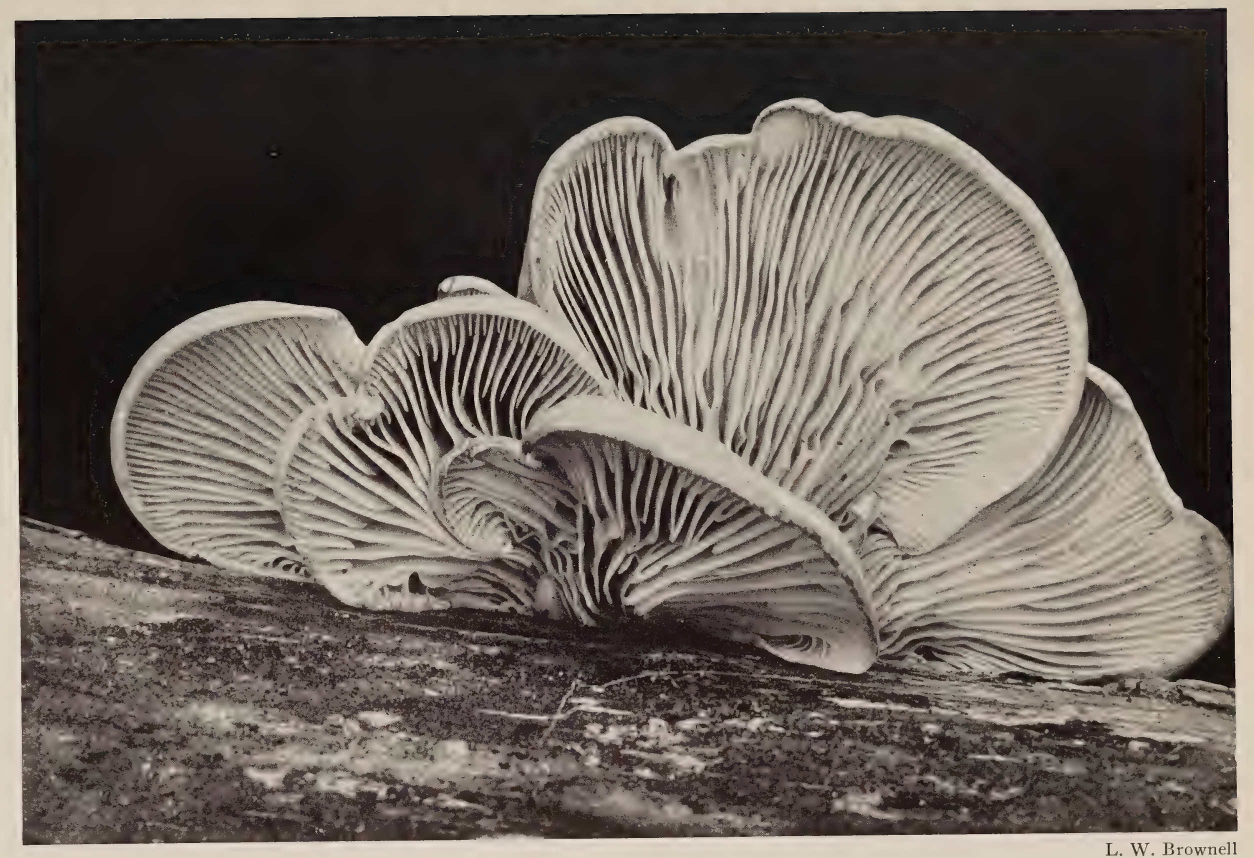
If only one season can be chosen for giving special attention to the woods, that season perhaps should be fall. But children should have woods experience in some degree not one fall only but every fall; and not in one season only but in all seasons of the year. So it should be true that any group of children around eight years old, entering upon a study of the woods specifically are not being introduced to something new, but merely adding to a continuous previous experience reaching back to the earliest age possible for them to be taken to the woods.

One October day a group of children living in the eastern United States invited their friends to come and see what they, the children, had been seeing that fall. The exhibit was laid out in an orderly and beautiful way on small tables covered with neutral toned paper. It was presided over by children ready to help the visitor to see and get the meaning of what was there. The range of display was wide. Graceful stems of grasses and weeds in the seed stage, some fountain-like, some branching or in other form, were exhibited mounted—the dark ones on light backgrounds, the light ones on dark. Sprays and stalks of special beauty, those of wheat, witch-hazel, Chinese lantern, hops and alder, were provided with special mountings velvety in texture and lovely in color contrast to their subject, made with pastels by the children. Stalks of imposing tallness, cat-tails, teazle, mullein and others, stood up effectively in groups of their kind, set in bases of clay.

At one table a demonstration of the opening of a milkweed pod was given, and at another a stalk of blown milkweed seeds was on view, in a spot where it captured the sunlight. Examples of perhaps a dozen traveling seed forms were displayed and made to show their manner of locomotion. The usual gay fruits of fall were there too, and seed berries, gourds and nuts. Also fall "flowers," the little flower-like involucres which, in plants like wild aster and thistle, persist in a dried condition when the real flowers are gone. Pine cones were included, greatly varied in size, shade and shape; also the homes that are found in fall—the bird nests, the wasp nests, the cocoons, and the so-called seed houses; bracket-fungi, mushrooms and lichens in varied forms and in woodsy colorings of brown, gray, black, gray-green, yellow, orange and henna; bits of moss and lichen to be looked at through magnifiers, and a blue print collection of grasses and leaves.

Queer things, as the children called them, were exhibited too. Among these were a puff ball which could be made to puff seeming smoke like a little volcano; a piece of wood showing the symmetrical radial borings of a bark beetle; a stem stung by an insect; catalpa beans that quickly become hot when you rub them; a chip of insect-bored, rotted wood thought to look like a Gothic cathedral; seed capsules that could be played with like rattle-boxes. The entertainment ended with a little woods play made and acted by the children, the giving of a fragrant Osage orange to each guest, and an impromptu dance out-of-doors around a huge pile of leaves.

When engaged in study of woods or field it has proved interesting to play a game in which each one marks off a prescribed number of square inches of ground, not more than



L. W. Brownell

THE UNDERSIDE OF THE OYSTER MUSHROOM

ten or twelve, and within a specified time, five minutes or longer, sees how many interests in plant or insect life or in minerals make themselves known to him, within these narrow limits. It is a wonderful way of discovering the tiny perfections of nature which our ordinary behavior never lets us see. Children of Pine Mountain school in Kentucky have in the past had the custom of sending to friends at a distance little hand-made rush baskets filled with soil in which were placed mosses, tiny growing ferns, scarlet snow-berries, and other small treasures of the mountains which can safely travel by post. These are both good ways of experiencing woods beauty intimately; and children who follow them are likely to hold the remembrance as long as they live.

Coming back from a woods trip laden with moss covered stones, dead sticks made beautiful with shell-shaped growths of soft-colored fungus, tiny snail shells, branches of pine cones, several kinds of nuts or any other of the numberless finds that give pleasure and do not rob the woods, gives evidence of a happy adventure and the children's awareness of what is beautiful and interesting in the everyday world around them. Another aspect of the children's appreciation of the woods is their willingness and desire to leave an especially beautiful thing undisturbed in its natural setting, that others may enjoy the same impression which they themselves received; or to prevent extermination of something whose appearance is growing rare.

In their woods walks children have learned the contribution which silence, invoked now and then, can make. A little girl has expressed it thus:

Once in the woods
We played a game of perfect silence,
And then we heard:

The wind blowing
In the trees,
The leaves crackling
And the water
Rushing down the rocks.

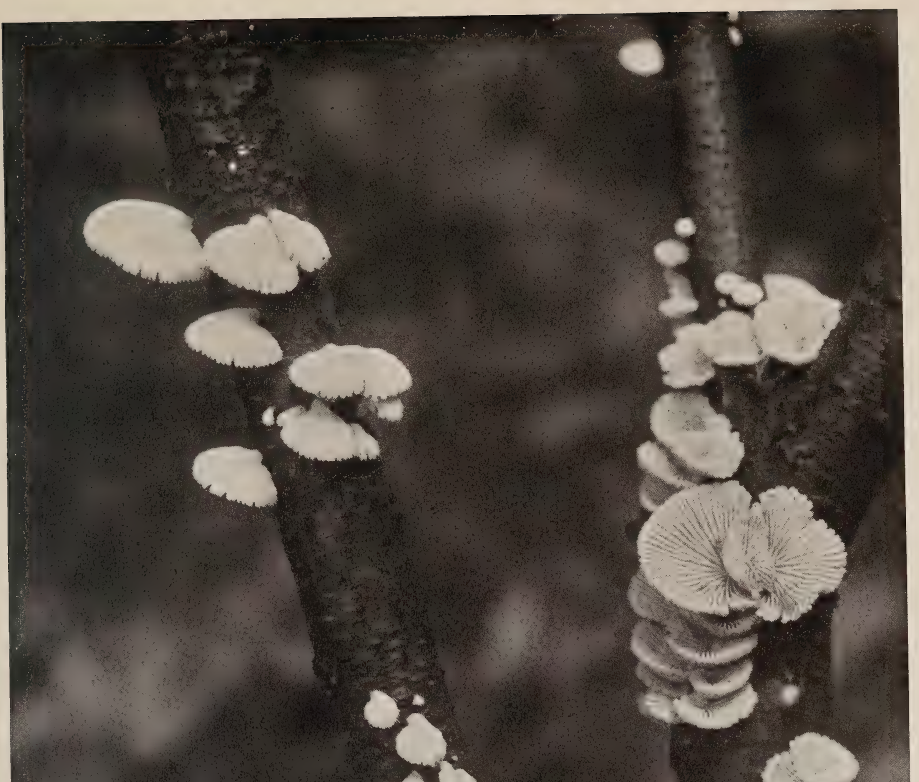
Until human sounds are stilled, the woods cannot be heard. It can be a rule of a woods walk which children will heed and enjoy, that any member of the party may request and get silence for a minute or so merely by raising his arm as a sign that this is wanted. The purpose may be to hear a bird's call better, to get close enough to a bird or a chipmunk to see it, or merely to enjoy briefly whatever sounds the woods may then be offering. Sometimes a sudden experience of woods beauty has brought silence to a group without their intending it. Another game of silence is that in which the children walk in a line, without speaking and with quiet footsteps, following a leader. At times this leader stops to indicate some interest, by pointing. Leadership is alternating, one child taking it briefly and then yielding it to someone of his choosing. Still another game proved profitable for children is that of sitting quietly in the woods for a few minutes, thinking of all the activity that is probably going on around them and then telling these thoughts aloud. Another is playing Ants' World, a game of relativity which rests upon imagining that ants see and feel as humans do. It assumes that big things are big, and little things are little, in definite ratio to the size of the beholder. What to humans are the slightest irregularities of the ground must seem hills and valleys to the ant; a fair-sized stone is a cliff, and a paved road is a desert of Sahara. Thus in a woods walk, out of seemingly very little material, a world of scenic grandeur can be built up for the ant, abounding in mighty forests, canyons and gorges, rushing rivers and waterfalls.

Children are fortunate who live near woods in which some animal wild life remains. A little rustling noise in the leaves near the path, and a cotton-tail hopping out of sight; a nearly tame chipmunk who lets small watchers see him run back and forth in his busy play; a light movement of a bough followed by a squirrel's undulating leap; and more rarely a woodchuck waddling across a clearing—these are fascinations which belong to children and they should have them if it is in any way possible to provide them.

The next best thing to actual experience is to read books that tell the truth about the ways of these little animals; and then go to the woods, and imagine them, and play them. For I think children know no better fun than play of this sort in the woods. All the sharp, quick, watchful or playful little ways of animals children seem able to appreciate, and to imitate with a wonderful degree of humor and understanding. The books which I have found most useful for this purpose are those of John Burroughs, Dallas Lore Sharp and Thornton W. Burgess. This is an extension of the animal play referred to in the preceding chapter.

If children become interested in learning about the woods in general through watching and waiting and their circumstances provide time and opportunity for this, they can become largely self-taught; and what they learn themselves, unguided, they will not be likely to forget. A boy who discovers in the grass what appears to be a single file procession of black ants and spends an hour or so trying to find out whence it comes and whither it is going, and why, and how, is bound to know something true about ants. Any child who fixes his attention upon some individual bird or other wild living thing and watches it consecutively and repeatedly enough to learn its routine from day to day will be well repaid for the trouble. A certain writer of the habits of birds does not go on so-called bird walks. When she goes to the woods to see birds, she dresses in the brown of the tree trunks, takes a note-book of tan-colored paper, her luncheon and a camera, and finds a comfortable place for sitting. There in quietness and inconspicuousness, she waits for the bird drama to begin, and there she remains all day. This true story seems always to interest the children who hear it.

Some idea of the rewards of waiting has come to children through the reading of the woods adventures of Burroughs: "I was amused one October in watching a chipmunk carry nuts and other food into his den. He had made a well-defined path from his door and through the weeds and dry leaves into the territory where his feeding ground lay. The path was a crooked one; it dipped under weeds, under some large loosely piled stones, under a pile of chestnut posts, and then followed the remains of an old wall. Going and coming his motions were like clock-work. He always went by spurts and sudden sallies. He was never for one moment off his guard. He would appear at the mouth of his den, look quickly about, take a few leaps to a tussock of grass, pause a breath with one foot raised, slip quickly a few yards over some dry leaves, pause again by a stump beside a path, rush across the path to the pile of loose stones, go under the first and over the second, gain the pile of posts, make his way through that, survey his course half a moment from the other side of it, and then dart on to some other cover, and presently beyond my range, where I think he gathered acorns. . . . In four or five minutes I would see him coming back, always keeping rigidly to the course he took going out, paus-



L. W. Brownell

FLOWER-LIKE FUNGUS FORMATIONS THAT GROW ON DECAYING WOOD

ing at the same spots, darting over or under the same objects, clearing at a bound the same pile of leaves. There was no variation in his manner of proceeding all the time I observed him." [4] Another enjoyable writer of this type of observation is Enos Mills.[5] The watching is not always rewarded with such definite gains of information; but there are probably in any case gains to thought which make the experience worth having.

I've watched you now a full half hour
Self-poised upon that yellow flower,
And, little butterfly, indeed
I know not if you sleep or feed.
How motionless! Not frozen seas
More motionless! And then
What joy awaits you, when the breeze
Has found you out among the trees,
And calls you forth again!

There is a time in childhood, fortunately, to get acquainted with trees; and an experience of the woods is, of course, largely an experience of trees. Children can know trees so well that they sense their individuality. Some selected tree on which and under which they play repeatedly can almost rank as a person, in their consciousness. Whitman, too, felt a tree to be more than a tree. He has said: "How the trees rise and stand up—with strong trunks and branches and leaves. I think there is something more in each of them. A living soul"; and also, "Why are there trees I never walk under but large and melodious thoughts descend upon me?"

It is interesting for children to know not only the kinds of trees which they see most in their woods walks, but to be aware of types of growth and development and to have some realization of the depth, spread, branching and size of roots in relation to the development of the part of the tree above ground. Knowledge of a tree in its entirety can greatly enhance one's concept of a tree as a form of beauty. It is worth while to seek out with children the trees of a neighborhood which have been uprooted, or those whose roots are exposed. It is interesting, too, to come upon a large standing tree which has developed freely and symmetrically, and to let the children study how this approximate perfection was attained. They have taken photographs of such a tree in the fall before the leaves went and again when winter has brought out all its above ground form. They have conjectured the size, shape and location of the roots necessary to hold it up and feed it. They have gained thus perhaps some realization of the tree's greatness and strength in relation to unimpeded development, and have noted its capacity to give shade and shelter throughout every hour of a day. By contrast, the children have observed and photographed also other trees which show effects of conditions of crowding and other interference, exposure, wearing or digging away of foundations, inundation, blights. The shapes which these malformed trees exhibit are interesting because of what they reveal of the life of a tree. Experienced trees such as these, are the ones, we know, which artists like to paint.

---

[4] Squirrels and Other Fur Bearers. p. 15.
[5] See Waiting in the Wilderness. p. vii.

It has also been interesting to children to gain an impression of the comparatively great age of fully developed trees, and to learn about and understand the ring-counting process which tends to reveal this knowledge. Great shade trees specifically planted for protection and beauty are demonstrations of human altruism worth reflecting upon; for no one who plants a tree can realize upon it as his posterity can.

To gain some comprehension of the marvel of the long steady growth of a tree children can start with the observation of tiny growing seedling maples or spruces, or any other available kind to be found in their neighborhood. They can measure the height of one of these at a certain date, putting a tag on it for identification and record, and then measure it again at the end of six months and of a year. It has been proved a good idea to take children to a nursery when there is one accessible and let them learn the ages of the little trees they see there at the varying stages of development which are represented. It has seemed profitable, also, to let children plant in some place where trees are needed young trees obtained from a nursery, trees whose history they have learned, in order that they may watch and tend their growth and feel that they are making a contribution to a future beyond their own.

It is not mentally lazy to lie on the ground in the woods and watch the vibrating movements of the over-arching tree tops, and the changing lace-like patterns they make against their background of sky. Boughs at first apparently motionless are, with watching, seen to be tossing, swaying, dipping, receding, meeting—the visible record of the invisible wind, written in rhythmic beauty in movement like a dance. The movement of a tree is further sensed by standing as close as possible to it, clasping its trunk. Children experiencing this for the first time are surprised by the rhythmic pulse they feel, and the movement response which takes place in their own organism. Of course, as a means of experiencing trees, nothing can serve children better than climbing them. Primarily, in a child's world, that is what trees were made for.

In the drawing and painting of trees children have been encouraged to work sometimes in a very large way, representing trunk and branch in great, sweeping, rhythmic lines perhaps several feet long. This is a free, enjoyable way of working, and it can produce results of clarity, naturalness, strength and rhythmic grace. The media found best for it are lecturer's chalks or pastels, and tempera paints applied with a flat, long-handled brush.

Rocks

When the topic of rocks has been reached it has seemed advisable to review with children what they formerly learned of the three categories of rock-making: igneous, sedimentary, metamorphic. They have in most instances been able to get acquainted directly with the appearance of surface sedimentary rock in place; and in most localities they have been able to find at least sample fragments of the other kinds. They have learned something of shale, sandstone and limestone and their metamorphosed formations of slate, quartzite and marble. They have learned something also of conglomerate and of granite. If they attain an understanding knowledge of these rocks, they have basic information of the topic as a whole. Colors, stratification, folds and weathering in sedimentary rocks have usually been illustrated in the children's own or a neighboring locality.

So far as possible the children have been helped to see rocks in many aspects: bowlders, crags, cliffs, pinnacles, precipices, ledges, caves, natural bridges, and those curious and often beautiful sculptured rock forms which seem to have architectural or animal or human resemblance. Hawthorne's delightfuly told and impressive story of The Great Stone Face has proved a good interpolation at this point of rock observation. If children cannot see these various rock appearances at first hand they have been shown photographs and stereographs of them. These substitutes can portray form and even structure very well; but they are limited in what they can impart of color, of the play of light and shade, of the beauty of fern-grown ledges, and the coolness of caverns. And nothing but actual experience of rocks can bring out the possibilities of the fun they offer to children, whether in clambering, sliding, or leaping, perching on pinnacles, or hiding in recesses.

Rocks, like mountains, can convey to one ideas of solidity, grandeur, permanence; and they are probably the best illustration physical nature affords of such qualities. And yet the rocks, even more appreciably than the mountains, are subject to the ever active processes of change.[6] The wearing away and breaking up of rock through the agencies of wind, extremes of temperature, water, chemical action and gravity, are for the most part a comprehensible and interesting topic for children and one which is susceptible of illustration in field trips, in the laboratory, or in any natural outdoor situation. The subsequent activities of deposition, compression and cementing are within their grasp also, although less adapted to objective representation.

This cyclic process of rock wearing and making takes thought back to past ages when, by the action of the atmosphere, rain and running water, the original surface rocks of the earth's crust were broken up and much of the rock waste was taken by the streams and carried by them to the sea. Thus sediments accumulated gradually until they attained a depth of thousands of feet. The weight of the upper layers compressed the layers beneath them, and the sea water was squeezed out more and more. Natural cements which were in solution in the water operated to set and hold the sedimentary particles into firm shapes; muds became shales, sands became sandstones; and pebble beds became conglomerates. In time pressure and cementing converted the loose, disintegrated materials into solid, sedimentary rock. When, by the recession of the sea or from other causes this becomes surface instead of undersea rock, it is subjected all over again to the processes of weathering, erosion and transportation which the beginning of this statement set forth; the principle of "over and over again" represented as truly, in the story of the rocks, as it is in the different story of seeds. Children who have acquired information to this point have sometimes been left wondering how it is that sedimentary rocks can be found far inland, if they are built up under the sea. This has led them to the further information that in past geologic ages the seas overflowed much of the present continental surface; that we seem to have some proof of this in the sea-form fossils found in sedimentary rocks of inland regions.[7] Following this study children have made a pictorial chart in color, illustrating the agencies and events which produce the whole rock cycle.[8] Also they have represented a fairly wide range of rock aspects in paintings and clay reliefs.

---

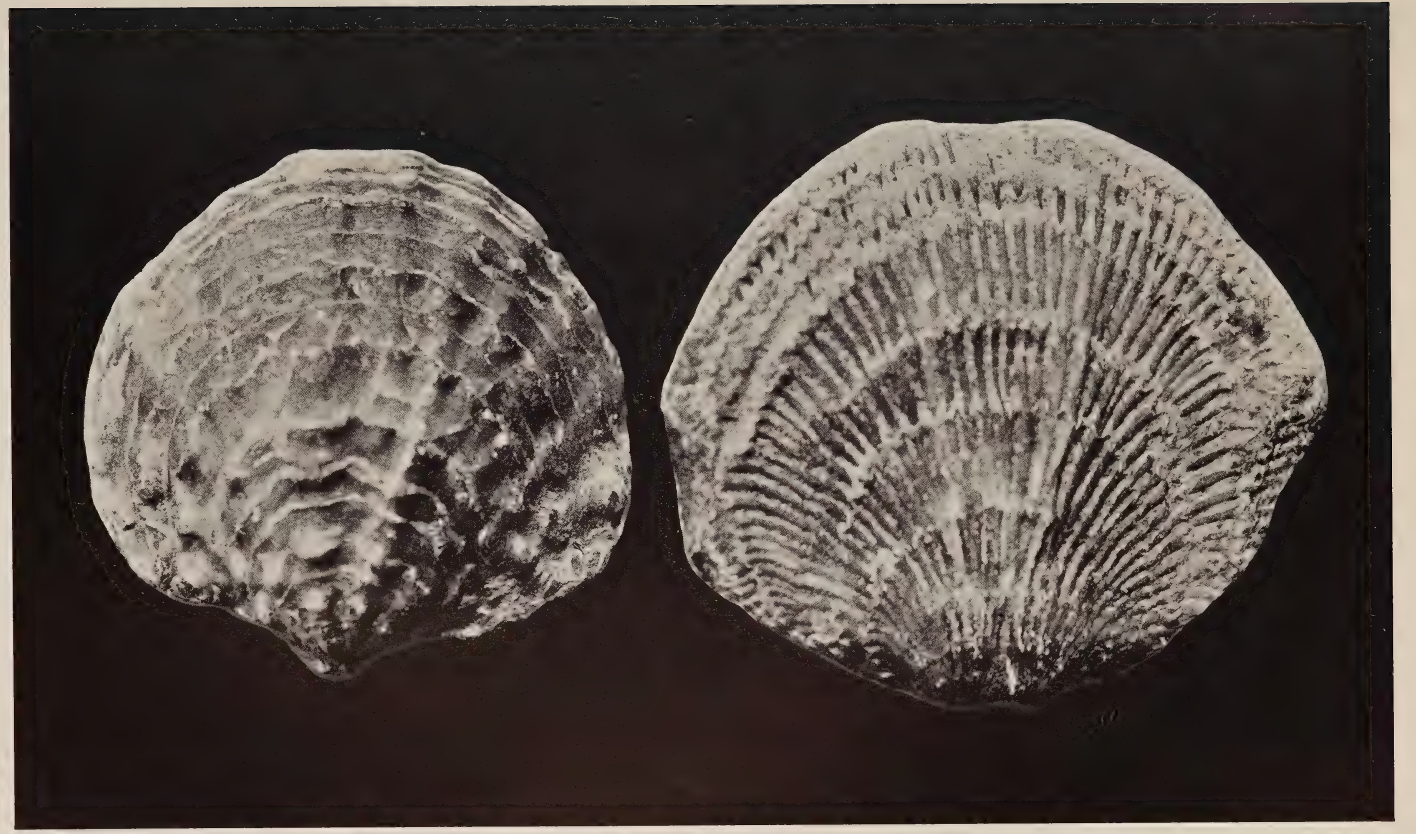
[6] See Schuchert and LeVene: The Earth and Its Rhythms. Chaps. X, XIII and pp. 22-24, 143. Whitbeck: High School Geography. Macmillan. p. 25.

A rock vocabulary, voluntarily compiled by a group of children, nine and ten years old, at the end of a period of rock study and experiences, and organized with adult help into its present order is the following:

---

[7] See Schuchert and LeVene: The Earth and Its Rhythms, pp. 135, 137, regarding epeiric seas and fossils.

[8] See same, p. 18. Chart, The Cycle of Rock Change.



Cornelia Clarke

FOSSIL SHELLS

THE EARTH'S SURFACE

crumbles
cracks
breaks
quakes
wrinkles
smashes
caves in
shakes
scratches
crushes
crashes
bangs
mashes
cuts
wears
hangs
leans
presses down
shoves
pushes
sticks
projects
juts out
tips
falls
slides
slants
rolls
soaks up

leveled down
rugged
smashed up
splitting
tumbling
crumbling
pushing
sinking
slipping
bare
breakable
fallen
hanging
overhanging
slanting
sloping
hilly
steep
rocky
sharp
blunt
rolling
leaning
firm
solid
slippery
brittle
strong
mighty
weathered
glacial
weather-worn
embedded
laminated
loose
porous
chalky
petrified
igneous
sedimentary
metamorphic
crystallized
crystalline
water-formed
native
conglomerate
decomposed
seasoned
stratified
interstratified
loose-grained
knocked-off
lumpy
bumpy
humpy
protruding
piled-up
rushed-together
top-heavy
step-like
towering
perpendicular
sculptured
carved
pointed
angular
square
rounded
triangular
level
smooth
marred
polished
coarse
soft
hard
chipped
mixed
ragged
jagged
rough
uneven
irregular
weather-beaten
black
yellow
red
grayish white
orange
light brown
mossy
beautiful
old
ancient
tall
great
huge
immense
gigantic
wonderful

glacier
lava
crater
deposit
vein
strata
fossil
ore
lode
outcrop
country rock
layers
folds
fissure
crack
cleavage
streak
hardness
stone
pebble
gravel
sand
metal
mineral
geology
quarry
mine
pocket
surface rock
quartz
agate
flint
feldspar
granite
limestone
sandstone
mudrock
shale
mica
copper ore
meteorite
slate
basalt
gneiss
iron
marble
building-stone
cobble-stone

paving-stone
wall
bluff
cliff
ridge
palisades
chasm
ravine
gorge
canyon
bowlder
cave
crevice
stalactite
stalagmite
pinnacle
parapet
cathedral rocks
dome
castle rocks
towers
beauty
grandeur
Balanced Rock
Garden of the Gods
Natural Bridge
Old Dr. Syntax
Old Man Hampshire
The Great Stone Face
landslide
earthquake
volcano
waterfall
mass
weight
pressure
texture
soil
jewels
gems
nugget
precious stones.
crystals
glacial action

Mountains

It has been my lot at times to work with a group of children most of whom had never seen actual mountains. A Japanese poet has anticipated this situation, for he says:

> A lucky find, the peaks of cloud
> For countries that no mountains see.

With the aid of various devices it does seem possible for children unacquainted with mountains to get a true if partial concept of them and a feeling reaction very like a direct one. One way in which children have worked to this end is that of constructing from clay, on the basis of photographs, stereographs and description, a model of a mountainous region. The mountains have been painted realistically; and fragments of rock, tiny twigs and sticks, and tip ends of grasses have been imbedded in the clay when these would help to provide the appearance of rock, standing timber, logs or scrubby growth. The realism has been carried farther by putting a river at the bottom, fed by trickling mountain streams; and, as in a stage or a museum habitat model, there was an extension of painted background curving into overhead sky. Mountains have been shown in ridge back of ridge, or peak beyond peak, according to the choice of region.

When the Southern Appalachian mountains were made, creeks with their branches were shown winding among the hollows. Diminutive log cabins made of sticks and clay, and proportioned to the height of the mountains, were placed in the hollows at lonely intervals along the creeks; and thread-made trails traversed the ridges connecting cabin with cabin. To get the realization it was necessary, in some degree, to imagine the life of the people. Sometimes the children made up stories about the adventures of persons who lived in this or that cabin.

Certain stereographs of mountains are exceedingly realistic; and children have sometimes looked at these a long while, with the feeling of actual presence. Remarkable lantern slides are obtainable too. The impressiveness of mountain heights has been realized in a measure by children through a mode of playing with pictures. For this are needed photographs of tall mountains showing a house or a village at the base. The children have covered with a card all of the picture except the house or village. They imagine themselves coming out of some doorway in the picture and looking in the direction of the mountain. They begin then to move the card upward slowly and steadily towards the top of the picture. Looking at the mountain their gaze travels slowly upward, keeping pace with the moving card. As they continue to look, more and more of the mountain appears until the summit at last is revealed. The experience can be had effectively if one looks in this way at the commonly seen profile photograph of El Capitan. The starting point can be the clump of small trees in the foreground, since the photograph has no houses.

Children have played with mountain pictures in several other ways. They have imagined in detail the experiences of a trip from base to summit, and the panoramic scene which they think might be viewed from a summit; they have speculated on what may lie on the other side of a mountain. In this last connection the story of the Osaka and Kioto frogs [9] finds amusing application.

A writer who can help children to see and feel mountains if excerpts from her writings be taken is Charles Egbert Craddock.[10] She pictures shadows that creep up the slopes of the Great Smoky Mountains at the end of day, mountain streamlets that "channel the gullies and swirl among the bowlders," peaks that are always touching clouds and wrapped in mists, and ridges blue with distance. Of one mountain she writes, "Whether the skies are blue or gray, the dark austere line of its summit limits the horizon. It stands against the west like a barrier. One by one the days passed over it, and were received into the heavens and returned no more." Clear impressions of mountains can be gleaned from the Legend of Sleepy Hollow and from the child stories of Heidi and Moni the Goat Boy.[11]

For children who can have it, real mountain climbing should surely be arranged. It may have to be deferred to a summer camp experience. Climbing to a mountain top on a summer evening, spending the night there in the open under the stars, and getting up for the sunrise has proved possible even for little children, under certain conditions; and those who do it may get a zest for mountaineering that will persist through later years. One does not know mountains first hand until he has actually climbed them. But playing at mountain climbing can help, and it can be inspired by even a slight elevation; if hills and rocks are available, these of course serve still better. Children have been mountain climbers on the little hillocks of a golf course, yodeling to far off companions when they were in the Bavarian Alps, or calling a friendly "Howdy" to a cabin in the hollow, when they trailed Kentucky's Pine Mountain. This kind of mountain play has special value in vocal outlet. Playing echo is another voice-releasing, and often musical, game; and if, when the sounds are directed against a mountain-side or its representative this fails to do its work, a group of children standing there can send back to the shouters an echo-like response. To the auditor, this can seem like antiphonal music. The more detail children have assembled about mountain climbing, mountain scenery, conditions of mountain living, mountain animals, and mountain sports, the more fun they can have in their playing.

---

[9] Baker and Thorndike: Second Reader. The Macmillan Co., 1928.

[10] In the Tennessee Mountains. Houghton, Mifflin Co.

[11] Johanna Spyri.

When children really know mountains through first hand experience, through play and other means, it is time to talk about what mountains are and how they came to be. As in the case of rocks, children have been surprised and interested to learn that the mountains have not always stood as one sees them now; that if one could look at them some ages hence marked changes might appear. Again are brought to their thought the ceaseless activity and the cyclic flow of natural processes. One writer says, "And so mountains are built up and worn down in endless succession. There are three stages of mountain making: (1) the forming and hardening of the rocks; (2) the folding; (3) the uplifting. There are three stages of mountain destruction; (1) the splitting; (2) the transport of particles; (3) the forming of new rocks (and this is the first stage of mountain-making). One generation of mountains follows another." [12] Mountains do not all come about in the same way, although at base they all have the same factor of crustal movement.

---

[12] J. Arthur Thomson: The Outline of Science, vol. IV. p. 936.

The foregoing statements refer particularly to the fold type of mountains, wherein the earth's crust has been arched and hollowed through lateral pressure just as a sheet of paper will wrinkle if the two sides are pushed towards each other. The sites of such mountains are determined by zones of weakness in the earth's crust. There a sinking takes place under vast amounts of accumulated sediments. Following this subsidence the crustal pressures push the accumulation into folds and crush these together until the whole mass rises as a mountain elevation.[13] We cannot witness the making of a mountain; but its destruction is apparent to us continually, and in many ways. Other types of mountains are those termed residual, which have been carved by erosion from a plateau or other extended elevation; and mountains of accumulation. These last are illustrated by volcanic mountains built up by erupted materials from deep within the earth's crust.[14] In this connection children have been acquainted with the fact that vast masses of molten igneous rock have in some instances been up-welled, from great depths, into the folded mountains and thus produced their treasures of mineral wealth. All these types, and their variations, children can construct with a degree of clearness from clay.[15]

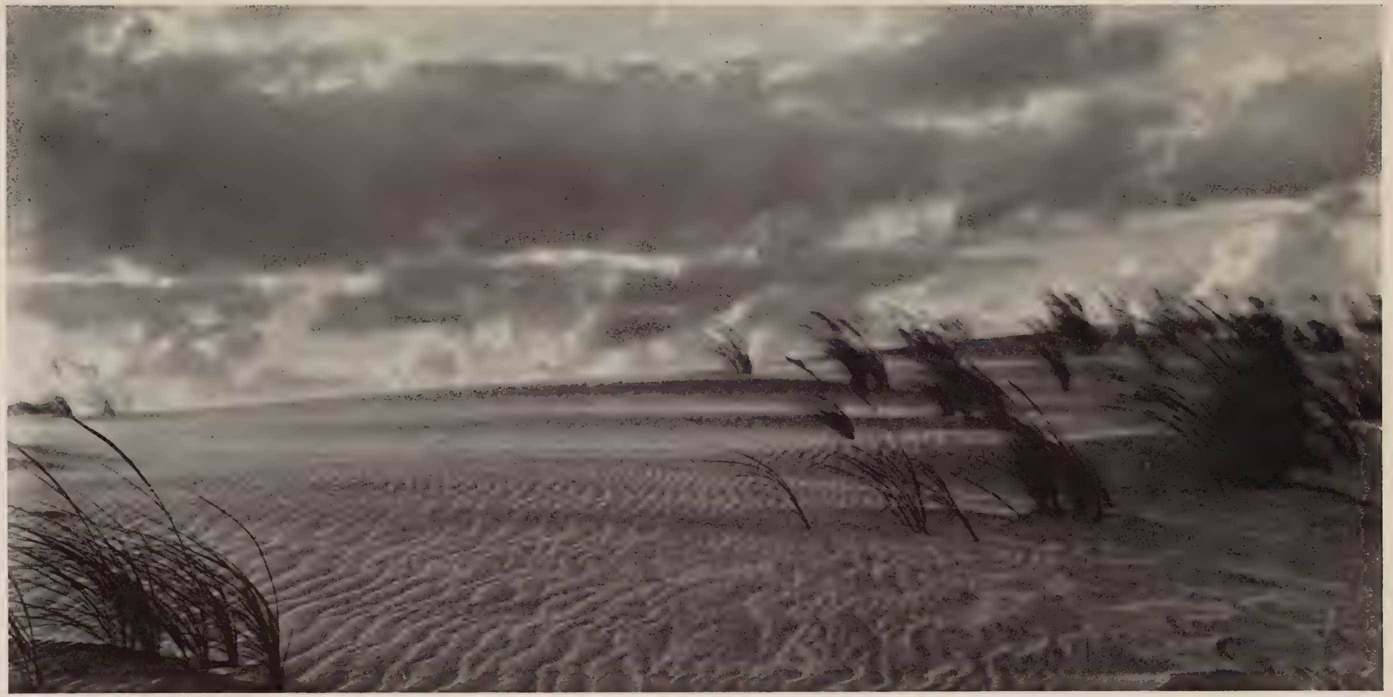
A large wall map of the hemispheres has been displayed in the room in which the children spend most of their time; also a large, clearly demarcated globe of the earth. On these maps the principal mountain systems of the world have been

---

[13] See Schuchert and LeVene: The Earth and Its Rhythms. p. 217.

[14] See same. pp. 186, 189, 222.

[15] For diagrams which will aid this work see Rollin D. Salisbury: Physiography. pp. 446-449.



H. C. Mann. Courtesy of *National Geographic*

WIND RIPPLES IN SAND

located and each mountain type has found its illustration. The children have themselves made the largest practicable wall map of the earth in hemispheres, painting the oceans and larger lakes, and covering the outlined land parts with plasteline in a mode similar to that employed in making the world's minerals map of the previous year. A floor map might serve better because it could be even larger. They have put in the relief of the principal mountains of the world with great care, trying to render the topography with an approximation of truth in line and proportion.[16] This map, like the printed wall map and globe, has been kept in view in a much used room, so that the physiography of the mountains of the world and other features can sink into the children's consciousness. In this experience they have been informed of the scientific suppositions regarding the continuity of great mountain systems which, because of submergence beneath the ocean, appear to be separated. The western coastal ranges in the two Americas exemplify this. Along with the concept of the physical features of the mountains which they have put on their map, children have been given some idea of the lives of the people whom these conditions may affect; for only in this way are the mountains likely to seem actual to children.

I have never known children who did not love to make representations of mountains in painting. The mountain subject is one that links itself to great sweeping lines, whether they be the long flowing sky-lines of ridges and ranges, the up-and-over tracery of peaks, or the sheer drop of cliffs. This work invites large, free movements, helped by free-working media and almost unbounded space. Most Japanese artists' representations of Mt. Fujiyama can leave little doubt in the mind of the beholder that the line of the mountain was drawn with one sure swinging stroke. A feeling for the height of mountains and their rhythm comes out in the drawing; color, in the hands of children, seems able to produce interesting effects of surface texture or distance and to impress one with mountain beauty, isolation, grandeur and strength.

---

[16] For relative heights of mountains see Rollin D. Salisbury: Physiography. pp. 440-442.

Mountain ideas lend themselves to imaginative representation in rhythmic pantomime. The following are examples of plays of this kind, created, produced and recorded by children.

A Play of a Mountain Peak: The beginning is a forest. A little girl is dancing among the trees. After a long time she looks up through the trees and discovers the tall mountain peak. That is the end of the play. People think there are no more mountains, but back of the peak there are miles and piles of mountains.

Following a Star: This is a play of a man, a mountain and a star. There was a man going up a mountain. He sees a bright star high up in the distance. Afterward it seems to be going down, behind the mountain. It is getting towards daylight. Then he tries to follow the star down the other side of the mountain. But the star disappears and he lies down on the ground and goes to sleep. The grass is so high he pushes it off, and it goes over him like a blanket.

The Mountain Eagle: Once there was an eagle. He lived on the side of a mountain. One day he was on another mountain opposite his nest. He flopped his wings and flew to the ground. Then he flew in spirals, going higher and higher as he flew. Then he rested his wings as he went sailing and soaring through the sky. Then he flew over to his nest and spread out his wings over his babies.

The Sun Behind the Mountain: There is a long low mountain and the red sun behind it. The mountain just stands still and the sun looks as if you could touch it, it is so low. Then the sun goes very slowly down behind the mountain and these are the colors—orange and blue and purple. Then the mountain looks almost black. This is all happening while the sun is going down. Then all of this goes away and it is dark, dark night.

The Winding Trail: Lots of people take hold of hands and go winding up the mountain. They take hold of hands because the mountain is so steep and they want to keep from slipping. They are going over a trail that perhaps a bear or a deer made going over the mountain long ago. The people pull to help each other up. When they get up to the peak they drop hands and turn around, and they see valleys and other mountains and the trails on them. They see log cabins between the mountains, and the trails that the people who live in the cabins made to visit each other. The valleys seem far down below.

These pantomimes, when presented, were almost wholly without setting. The peak and view were merely imagined. In the star play the child who took the part of the traveler had to represent by his movement first climbing, and then descent. Tables covered with rock-resembling dyed muslin served for the eagle's mountainside resting places. The mountain in the sunset play was made by a standing row of eight or ten children of varying heights, covered with a piece of unbleached muslin more than twenty feet long and about five feet wide, dyed in colors like dark toned earth and rock.

The different heights of the children provided the wave-like sky-line. The sun was a hoop covered with an orange silk scarf.

Rivers

Stevenson tells how Will o' the Mill, in his childhood, lived in a falling valley of a river between pine woods and a great mountain.[17] All day as he watched the river, the boy wondered "whither [went] the water of the stream, ever coursing downward and ever renewed from above. . . . One evening he asked the miller where the river went. 'It goes down the valley,' answered he, 'and turns a power of mills—six score mills, they say, from here to Unterdeck—and is none the wearier after all. And then it goes out into the lowlands, and waters the great corn country, and runs through a sight of fine cities (so they say) where Kings live all alone in great palaces, with a sentry walking up and down before the door. And it goes under bridges with stone men upon them, looking down and smiling so curious at the water, and living folks leaning their elbows on the wall and looking over too. And then it goes on and on and down through marshes and sands, until at last it falls into the sea, where the ships are that bring parrots and tobacco from the Indies. Aye, it has a long trot before it as it goes singing over our weir.' "

Stevenson has again expressed the activity and the seeming adventurousness of a river in a poem which most children know, part of which is quoted:

> Dark brown is the river,
> Golden is the sand;
> It flows along forever
> With trees on either hand.

---

[17] R. L. Stevenson: Will o' the Mill. Chas. Scribner's Sons. pp. 241, 242.

On goes the river
A hundred miles or more;
Other little children
Will bring my boats ashore.

Another writer pictures vividly a mountain stream "gayly dandering down the valley, with the laurel and the paw-paw on its banks and the kildeer's nest in the sand,"[18] and its desperate plunge into the unexplored caverns of the mountain.

Two children of a group wrote contrasting stories of rivers. One story, called How the River Has Fun, is the following: "The river runs fast. It gives a great splash if it goes over big rocks. It goes over them like hills and you see the rocks again after the waves pass. The river has more fun than we do, sometimes. The boys put their play boats on it and maybe it takes them to the other side, and it takes big boats a ride to the sea. Sometimes the river runs away with people's things and never brings them back. The river runs through grassy fields. The river loves to take a winding walk and it goes past the mill and visits a farm and scoots under bridges. When a river comes to a high rock it likes to take a big jump, and that makes a waterfall. It loves to play with the children."

The other story, called The Beauty of a Quiet River, is this: "A river is flowing along quietly among the trees. Soon a little girl comes along and throws in a dandelion and it floats almost over to the other side, and then flows on with the current. The river flows past meadows and little children and under bridges. Soon it comes to buttercups, daisies and Stars of Bethlehem flowers. The sky is reflected in the water and it is blue. The river is always beautiful as it flows along, and it is never lonely. At night it sees the moon, and the river sings this song:

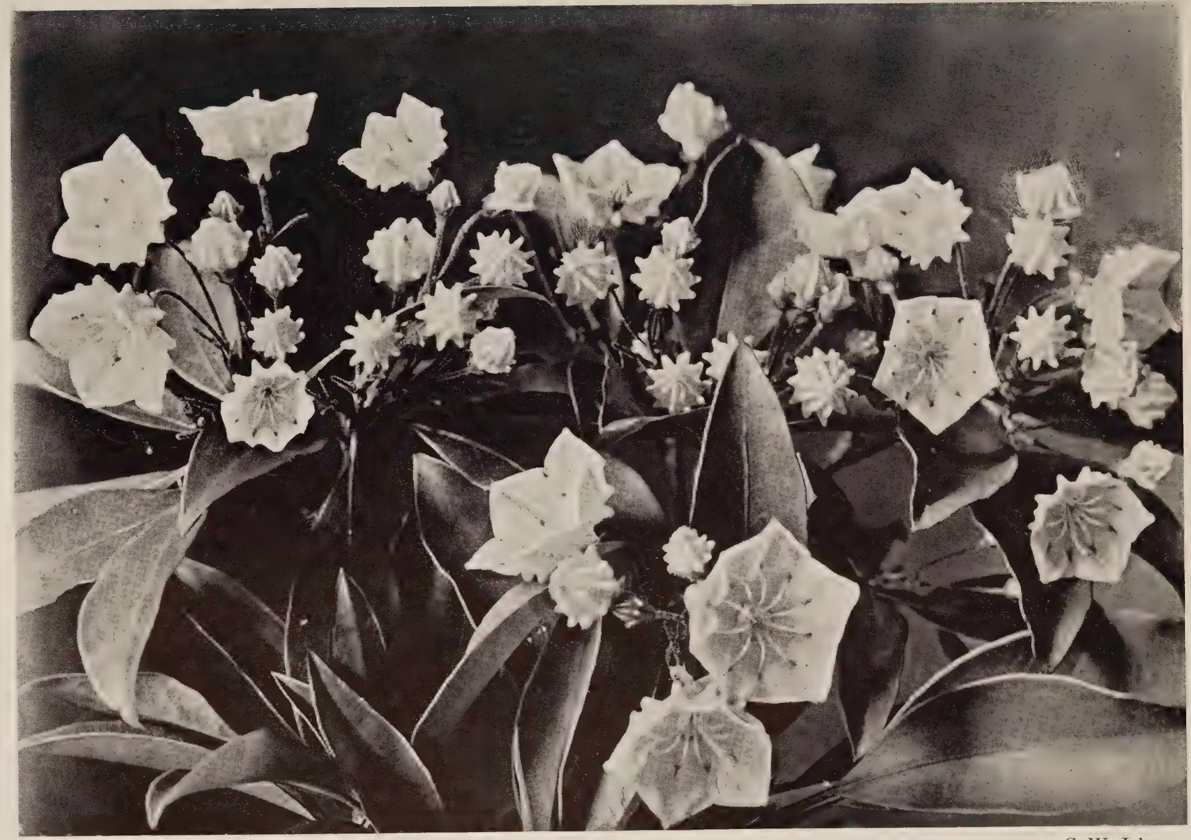
---

[18] Charles Egbert Craddock: In the Tennessee Mountains.

> Splash! I go over the stones.
> Then hark! everything is still.
> All is quiet now
> And everything is still.
> The moon looks down
> And sees his own reflection in my water.
> Sh, sh, sh, I say
> As softly I flow away.

"As the river goes on it sees trees blowing in the wind, and it thinks about itself long ago when it was a little rill making the grasses bow down as it flowed along its way. Oh, river, you are beautiful and you are very happy."

River play or brook or creek play, or all these failing, rain-river play, has probably from the beginning of time proved fascinating occupation for children. Hours and hours are needed in childhood for the fun of sailing real toy boats or make-believe stick boats rigged with leaf sails; of building dams; of following leaves, sticks or logs through all the adventures of running aground, getting caught and strangely swirled about by snags, being buffeted and deflected by rocks, flowing calmly and swiftly with the current in clear channel in open water, going bumpily down little cascades, plunging with a waterfall, or resting in port on the opposite side. And with it all children are unconsciously learning things: the direction and force of the current, the location, width and depth of the channel; the clearness and muddiness of the stream and the reasons for this; the river's work of transporting substances and the relation of their weight to their



C. W. Johnson

THE BLOSSOM OF THE MOUNTAIN LAUREL MAKES A PERFECT PENTAGON

transportableness; the wearing away of the banks, and many more. More or less unconsciously they absorb impressions of such beauty as the stream they play with may manifest—the willows and the alders that droop fountain-like over the banks, the damsel and dragon flies that quiver about in their hovering flight, the shores of reedy or tangled growth, or pebble-strewn sand, a shaded wagon road or footpath along the river's edge. They learn to look for wobbly, grotesque reflections where the water is disturbed or moving swiftly, and for clear, colorful images where the flow is steady and slow. They see the sunlight dancing on ripples, and the quiet depth of pools. On a magnificent scale or a diminutive one, they will perhaps see rapids, eddies, waterfalls, whirlpools and cascades.

The sequences of running water make a true cycle. Beginning with tiny streamlets brought into being by melting snows, rainwater and springs, and coursing down a mountain side, the story goes on through chapters of brooks, creeks, rivers, a greater river, and finally a merging with the sea. Water vapor from the sea falls as snow or rain, and the story begins once more.[19] These sequences have been represented by children in a series of drawings in color. A river with its tributaries and branches is clearly illustrated in a chart which a geography text provides.[20] Tennyson helps the story to be realized with his poem, The Brook.

> I come from haunts of coot and hern,
> I make a sudden sally,
> And sparkle out among the fern,
> To bicker down a valley.

---

[19] See chart of the water cycle, Schuchert & LeVene: The Earth and Its Rhythms. p. 31.

[20] Tarr and McMurray: New Physical Geography. The Macmillan Co., 1920. p. 35.

By thirty hills I hurry down,
Or slip between the ridges,
By twenty thorps, a little town,
And half a hundred bridges.

. . . . . .

And out again I curve and flow
To join the brimming river,
And men may come and men may go,
But I go on forever.

I have not found the unusual words in this poem an obstacle to children. They like them and will work to know the meaning.

Knowledge of river origin and destination and of the parts of rivers leads children logically to the study of maps. The great river systems of the world have been found on printed map and globe, their sources conjectured and ascertained, the tributaries and branches followed, and the mouth located. The flowing of rivers children easily attribute to gravity; but they have had to be told about watersheds as a determinant of flowing direction. What they have learned of river systems from the printed map has been transferred to their own relief map, begun in the study of mountains.

The work of a river from the geologic standpoint includes, (1) sculpturing the part of the earth's crust it passes through; and (2) the transportation of waste.[21] A river's trough, with its gorges or canyons made by relatively young rivers and its meanders made by old ones, its valley and basin all need to be understood in connection with the first topic; its floodplains, bars, deltas and ocean-deposited sediments with the second.[22] The consummate idea gained concerning a river should be its momentous and unceasing activity.

---

[21] See Schuchert and LeVene: The Earth and Its Rhythms. Chaps. IV, VI. Rollin D. Salisbury: Physiography. Part I, Chap. IV.

The Sea

When Stevenson's Will o' the Mill had learned about the river, he carried his questioning further. " 'And what is the sea?' asked Will. 'The sea!' cried the miller. 'Lord help us all, it is the greatest thing God ever made! That is where all the water in the world runs down into a great salt lake. There it lies, as flat as my hand and as innocent-like as a child; but they do say that when the wind blows, it gets up into water-mountains bigger than any of ours, and swallows down great ships bigger than our mill, and makes such a roaring that you can hear it miles away upon the lands. There are great fish in it five times bigger than a bull, and one old serpent as long as our river and as old as all the world, with whiskers like a man, and a crown of silver on her head.' "

The sea derives its individuality from its vastness, its depth, and its might. Much more readily than the land, it conveys to the observer homogeneity and uni-action, whether expressed as it may seem through "peace that passeth thought," or apparently ungovernable turbulence, restlessness and fury. The most objective aspects of the sea, of course, can be dramatized with great realism as the children in the story of Rollo did it. But an experience of fundamental rhythmic movement which works in the realm of universal ideas can probably come nearer than other methods to imparting a true feeling of and for the sea. That is, it is possible that the essential quality of sea movements can be experienced by an individual through coördinated, rhythmic movements of his own organism. Ideas derived from the sea lend themselves easily and beautifully to rhythmic pantomime.

---

[22] See The Earth and Its Rhythms. pp. 34-37 and 138-140.

Children enjoy the familiar poem which begins, "The sea, the sea, the open sea!" They like the wideness it seems able to convey to consciousness. From the Odyssey of Homer, Butcher and Lang's translation, many a gripping expression of sea experience can be gleaned; and there is one also in a poem by Matthew Arnold:

> Now the great winds shoreward blow;
> Now the salt tides seaward flow;
> Now the wild white horses play,
> Champ and chafe and toss in the spray.

Other sea pictures are given by Whitman in his short writings, From Montauk Point and The Ship Starting; and by Masefield in Sea Fever. Tennyson's Break, Break, Break and Coleridge's Ancient Mariner reveal sea manifestations not covered by these other references; the Psalms of David hold to view "this great and wide sea, wherein are things creeping innumerable," and they acquaint consciousness with the space and freedom that soar through the lines, "though I take the wings of the morning, and fly to the uttermost parts of the sea."

Children who can get to an ocean, and especially an unfrequented shore, can have the glorious experiences of wind and wave, and sand play. If the situation allows them to see a simplified world—sand, sea and sky in unending stretch, and nothing more—it is likely to make an unconsciously accepted gift of ideas of rest and peace, and to store away for them a mental haven which the spirit forever afterward can inhabit at will. Jumping the waves, making a game of evading them, fearlessly running out to meet them, hearing the ocean's roar, and watching and feeling the splash and toss of the spray, are unforgettable enjoyments, too. A far horizon line intriguing with vague possibilities; a dark blue sea rising in crest after crest, flecked here and there with small busy whitecaps, or a gray sea, with its ceaseless, gentle heaving; ripple marks of wind or wave on the sand; the dome of sky with its slowly evolving and vanishing cloud forms; and all the changes of color, and the softening or deepening or fading of color, in sky and ocean and sand—these are all present and they are likely to be consciously or unconsciously seen and remembered.

All children who go to the sea-shore are accustomed to digging, burying and tunneling in sand, on a modest scale; but probably the greater number of these children are unaware of the big sand undertakings easily within their reach. It is possible for several children working together to make a cave they can go into; to erect a table of normal size and seats which they can actually use; or to build a circular seat which can take care of a dozen or more persons and provide in the center a spot for a story-teller or other entertainer, or for a driftwood fire.

Sand sculptures and reliefs of animals and other figures are a possibility too. On smooth hard stretches of sand, with a stick as tool, large landscapes can be drawn with great freedom, or maps, or geometric designs. Relief or sculptured representations of canyons, mountains, and other physical features of the earth are made more readily and perhaps more realistically with sand than with other media. Then, having made a structure, a drawing, a relief or a sculpture, and having retained it recognizably for a few days at most, the children have the experience of seeing wind, tide-water and gravity work upon their creation of sand until not a vestige remains.

Sea treasures in all their varied shapes and exquisite colorings are spread out to view on the white or gray sand at every coming of the tide. Fluted and radiated scallops and cockles, spiraling whelks and snail shells, dainty translucent jingle shells in black, buff, orange, white or gray, may be among those found; also the curious or arrestingly symmetrical forms of razor blade, star fish, sand-dollar, sea biscuit and jelly-fish. Seaweeds may be yielded, or sea fans and coral fragments. And every beach will be sure to have pebbles, wave rounded and ripple marked. Some of the shells will be found still enclosing the living animals; their presence is made known by little spurted streams of water, or their scurrying movement to bury themselves in the sand. What is more diverting than to come upon tiny wedge shells in their exquisite pastel colorings—gray, lavender, pink, white and gray-blue—in masses of thousands, digging into sand and out of sight in an almost unappreciable fraction of time? Sand-hoppers are interesting too, with their amusing, tumbling locomotion, disappearing with such swiftness that before one knows it he is looking at the sand burrows through which they departed; [23] and so also are the sidewise moving crabs seeking to return as quickly as possible to the region from which they were routed so rudely by the tide.

Twice during daylight comes the flood-tide when all these wonders and so many more may be brought landward, providing the joys of discovery. If the shore is a rocky one, children have the adventure of climbing far out on the rocks at ebb-tide and, when the tide is in, coming back, wading

---

[23] Kelenan and Ward: The Seashore Shown to the Children. T. C. and E. C. Jack, Ltd. p. 88.

The American Museum of Natural History

A JELLY-FISH, ITS LONG TENTACLES WAVING WITH THE RHYTHM OF THE SEA

through water. Under the rocks along the shore are those little sea grottoes, and those imprisoned little pools where, clinging to the gray rock, clusters of velvety dark mussels are found, and sea moss and barnacles.

The glass bottomed boat adds much to shore experience; for the sea gardens it reveals establish the living beauty of the sea. Corals and grasses are seen to wave in slow rhythmic harmony; fish flashing silver move calmly about; and tentacles of sea anemones and urchins undulate like the windblown parts of a flower. The adventure beyond this, the diver's descent into Sargasso seas, is for children and most adults a vicarious one. Fortunately Beebe's Arcturus and other journeys can be known to all through the written stories of them; and scientific undersea moving pictures, such as Beebe's and Pillsbury's, can be seen in some localities from time to time. It is true that most children of this country do not live near an ocean. But it is compensatory, in a degree, that some can experience the shores of large lakes; and much awareness of the sea has been gained from collections of shells, sea-weeds, corals, and other sea treasures when these are displayed in a way to bring out their individuality and to let children handle them, arrange them, and play with them as they have done in the case of crystals and stones.

After becoming acquainted with the sea in its general character the children have been interested to turn to the map and look at the surface shapes of the five oceans; also to hear what is known of the depths and relief of the ocean beds. Plains, plateaus and mountains they have learned lie beneath the surface. Undersea continuities conjectured or ascertained, as in the case of the plateau connecting the British Isles with Europe, have been of interest too; also foraminiferal deposits on the ocean floor, submarine banks; and the origin of islands. When this last point of information was reached, the larger islands of all oceans, in relief, were added by the children to the map they had been making. Coastline changes, due to erosion or accession produced by wave action, have been studied. Changes now going on have been learned of, too.[24]

Wave, tide and current, three manifestations of movement in the sea, should be understood and differentiated clearly. Children who spend time by the sea learn without being told to associate windy days with roughened surface and whitecaps. That wind produces waves is illustrated by fanning a shallow pan of water so vigorously that the waves fall over the edge. That in the open sea there is no progressive movement of water through waves, children can be helped to understand by noting that wave form passes through a waving field of grain while each moving stem remains fixed to the ground.[25] Children can learn the cause of breakers and undertow. And they can add much to the interest and joy of watching waves if they are taught the parts of a wave and if their rhythmic consciousness has been so developed that their own organism echoes or responds to the wave movements that they are seeing.[26]

The tide is a wave of immense base and three or four feet in height, out in the open sea.[27] It is produced by the attractive force of the moon and the sun. The passage of the moon over any part of the ocean causes the water to lose its globular form and become bulged there; and this happens simultaneously to the water on the side of the earth directly opposite because the same tidal pull affects the solid earth beneath the water. If the earth had no rotation, the tidal wave so formed would follow the moon in its motion around the earth. But because of the earth's rotation different parts of it are brought under the moon in succession, and the tidal wave consequently moves from one part of the ocean to another.

---

[24] See Joseph Le Conte: Elements of Geology. D. Appleton & Co., 1896. pp. 35 ff.

[25] See Rollin D. Salisbury: Physiography. p. 318.

[26] See Elements of Geology. p. 35.

[27] See E. J. Houston: New Physical Geography. p. 76.

These facts, referred to in the study of the earth in space, have at this latter point become understood more thoroughly; and they have been illustrated when possible by letting children live with their daily demonstration. Children of seashore experience have been witnesses to the clock-like regularity of flood-tide and ebb; and they have had proof of the transporting power of tidal waves in the accumulation of driftwood and other débris which litters the shore when the tide goes out. Spring and neap are for children merely new terms for tide situations they have understood as resulting from the coöperating and opposed attractions of sun and moon.

An ocean current is most easily conceived when thought of as a river, flowing through the ocean, but immeasurably deeper and broader than a river of the land. It is neither easy nor necessary for little children to understand the causes of ocean currents, though their previous knowledge of polar and equatorial temperatures may be an aid to that end. They can readily understand, however, that currents modify extremes of climate in carrying the warm equatorial waters to the poles and the cold polar waters to the equator; that the currents can aid the speed of vessels traveling in certain directions; and that they transport timber to high, timber-scarce northern latitudes. The courses of the principal currents have been traced out on printed maps, and the locations of the massed seaweed aggregations, the Sargasso seas, have been noted.[28] On their own relief map the children have represented all of this information.

Making paintings of the sea, large and small, in all its changing moods and colors has seemed to be an almost necessary outlet of expression for the ideas which sea experiences provide. Children have depicted the wide expanse of the whole, visible sea, or a single wave like Hiroshige's; they have shown quiet harbors, a wave dashed rock, boats, fishermen, light-houses, bell-buoys. A group of children received as a loan a collection of sea paintings made by an artist friend. These they arranged into an exhibit; and a title of the children's own making was assigned to each of the pictures. The list of these titles affords a partial summary of the children's thoughts concerning the sea: The Sea Window, Green Grass Blowing on the Dunes, Dancing Foam, Tide Coming In, Back-wash, A Sunny Day at Sea, One Cloudy Day at Sea, Sail Boats Riding on the Ocean, The Rolling Sea, The Tall Ship, Green Waves Rolling In, The Sea Birds' Happy Day.

The rest of the summary should take account of the sea's part in the making and changing of the surface of the land, in providing the earth with moisture, in affecting the earth's climate; its unified and concerted action; and, with all its might and vastness, its subservience to the influence of gravitation and its demonstration thereby of the interplaying of cosmic forces.

The idea of a window has been used in this study of The Earth's Surface that children may see singly, for study or other purpose, one significant or beautiful feature after another. It was suggested by a verse of a poem:

---

[28] For map of ocean currents see E. J. Houston: New Physical Geography. p. 81.

Through the window
Through the window
  Of the world.
Over city, over lea,
Down the river flowing free
To its meeting with the sea,
  I am looking
Through the window
  Of the world.

In unending succession this imagined window can frame such sights as hills, valleys, mountains, plains, deserts, rivers, canyons, waterfalls, jungles, woods and the sea. One window of a schoolroom was, by a certain group of children, sometimes called magic; and then it became possible to see through it whatever one wished. The children took turns looking through the window, and describing to the others what they saw. The suggestion for this game came from the reading of Dunsany's story, The Wonderful Window.

Another invention was a window made from a cardboard box. The box stood upright. The cover, used inside out, had a cutting in its upper half to simulate the frame of a window. This cover represented one side of a room, and it was painted appropriately to suggest the walls and floor. Little silk side-curtains were hung at the window and window bars added, to help the realism. The cover, in this inside-out position, was placed close up to the open box. Within the box, with suitably worked out background, were presented a series of "window of the world" miniature landscapes in relief, to be looked at of course through the window. They were reminiscent of the peep-shows of a preceding generation. It was an experience of continual surprises, for one never knew when an old setting would go and a new one take its place. A forest one day might be followed with a desert the next. Further, it was discovered that a mere painting or a photograph of landscape or seascape placed within the box, took on added perspective and realness.

As a result of these window experiences some of the children's paintings of the earth's scenic features were made very small and with great care and placed in little cut-out paper frames simulating a window. They also took larger frames of this kind, made of pasteboard, out-of-doors and used them as finders for composition and as guides to perspective, in making outdoor sketches. This brought them to a special sense of pleasure in the discovery of lunette landscapes, like those seen through arches of bridges, when they went for walks or rides. At this point of experience Whitman's short poem, A Farm Picture, was read and received with response.

But the study of the earth's surface has produced more than these pleasures. It has brought out, I believe, regarding earth, air, water, animals and plants, some concept of their basic interrelations. For example, the soil is affected both mechanically and chemically through the agency of water and the roots of plants,[29] and mechanically by burrowing animals. The atmosphere serves as a medium for the passage of carbon dioxide from animals to plants. Land and water have engaged in interaction throughout the geologic ages.[30] The interaction of air, water and sunshine makes an earth that can be lived on.[31] Such a view of the physical scheme of existence seems to illustrate a mosaic, or a concept of a whole made effective by the harmony of its parts. Through this study the attempt has been made to give children some realization, also, that the physical features of the world as we know them represent a stage of development; that the earth had an origin and a past and will probably have a future. Sir James Jeans [32] helps to awareness of this with the following estimates stated in round numbers:

---

[29] See Schuchert and LeVene: The Earth and Its Rhythms. p. 24.

[30] See same. p. 37.

[31] See same. p. 4.

Age of the earth, about	2,000,000,000	years
Age of life on earth, "	300,000,000	"
Age of man on earth, "	300,000	"

In the study of the earth's surface sequential activity has been demonstrated—in the great cycles of water, rock, glacier and mountain and in many other ways. These cycles and other sequences, the periodic crustal movements, the repeated spread and recession of oceans, the periodic revolutions of the earth with corresponding reflections in the seasons and their effects, all point to the rhythmic forces which support our physical existence and fashion our landscape into lines and forms of beauty. Through study of the surface of the earth children can, I believe, be made in some measure, aware of these things.

---

[32] The Universe Around Us. p. 13.

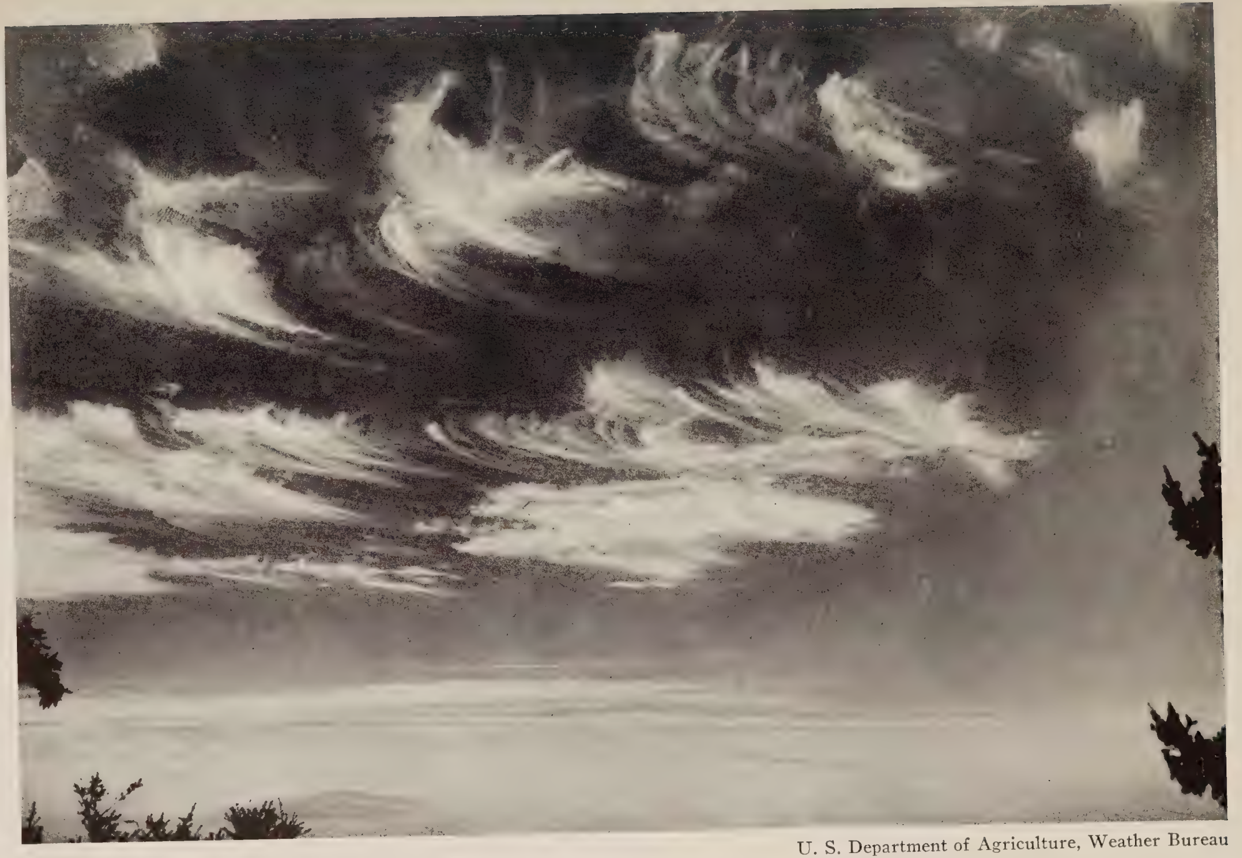
VI.

The Earth's Atmosphere

Up with me! Up with me into the clouds!
For thy song, lark, is strong;
Up with me, up with me into the clouds!
Singing, singing
With clouds and sky above thee ringing
Lift me, guide me 'till I find
The spot which seems so to thy mind.

IN making an inhabited world, how could creation have crowned its work better than by giving it a sky? For no matter what may be the local situation of the inhabitant of the earth—a congested city, a prison cell in Reading Gaol, a coal-blackened mining region—the heavens stretch curving above him as far as the east is from the west, a dome of exquisite beauty whose high zenith dwarfs every tallest vision that earth-bound things can give. The sky, just as material as the earth or any other part of the universe, may nevertheless seem able to speak to and respond to the spirit more infallibly. Does anyone who has spent hours, in total, looking into the deep unchanging blue of the heavens, or watching the slow, sequential, phantom-like movement of ethereal white clouds, regret that he has done it? Children see these things too. One child has written, "The clouds move in such beautiful order, in lovely slow movement and changeable shapes." Other children have expressed their experience with an approximation of metrical quality and form:

The sky last night—
All in black clouds,
And blue in between.



U. S. Department of Agriculture, Weather Bureau

CIRRUS CLOUDS OF DELICATE STRUCTURE APPEAR IN VARIED, SUGGESTIVE SHAPES

Like black rocks in water
The water moving gently
Around the rocks.

Oh, white drifting clouds
Oh, white drifting clouds
You are so beautiful to me,
You look like white shadows
Moving softly across the sky.

The golden dragons
Swooping through the sky
High in the air.
Through the clouds and lightning flashes
Over the mountains and up through the cliffs
Down through the lakes and the houses of sea-gulls
Over the wheat pastures,
The beat of their wings is the thunder crashing.

One of the pleasures of sky watching is found in imagined sky pictures. The measure of their beauty, fantasy and variety is the individual's own mental equipment. In sky watching one realizes upon his investment day by day in visual mental treasures. Sky pictures are objectifications of thought. They reproduce ideas gained through actual visualization, or through envisioned thoughts.

Unless one's consciousness had at some time harbored impressions of these things, how could he see in the sky the winged victory of Samothrace with her strength and freedom, or Adonis with his youthful beauty and grace; the chariot and plunging horses of the sun; polar bears poised on white icebergs; Fra Angelico's angels; dancers in exquisite rhythmic changes transcending the physical limitations of mortal bodies, or whole pageants of such figures in counterformations of advance and recession; continents growing from one into another; the Old Man of the Mountain slowly revealed and as slowly disintegrated; or the Colossus of Rhodes spanning an ever-widening sea? These are not primarily children's pictures because they are not primarily children's experience. But the operating principle is the same for children as for adults; and what they see in the sky is indicative of contents which they have received and made their own.

Descriptions of actual experiences in flying among clouds in an airplane are at this date new in literature. The following account is a paraphrased description of this kind by an English writer. He says, "The Lady Ursula sped, tail up, over the grass, bumped hesitatingly once or twice, and finally with a gentle heave took the air. The country round flattened out and assumed the appearance of a large map. A wisp or two of cold, clammy mist across my face and an admonitory jerk from the tail of the machine woke me from contemplation of Salisbury Plain to the discovery that the cloud level had been reached. Above and all around me was a dark gray ceiling formed by the underside of these great April clouds; from the ground they had seemed so uniformly flat, but viewed at this close range, they were amorphous masses of mist. . . . A clear patch of blue opened up above us, and a slight pull on the stick and a gentle pressure of the rudder bar put the well-trimmed plane into a leisurely spiral climb. We were soon engulfed between towering walls of fleecy gray, which merged gradually into the dazzling white of the sun-bathed upper level, 2,000 feet higher. . . . At length we emerged and climbed on into the pure cold upper air under a sky of the deepest blue. What a marvelous scene there met the gaze! On all sides as far as the eye could reach stretched tumbled continents of dazzling white, fading into delicate pearl tints in the distance, casting blue and mauve shadows upon each other. It was the domain of a snow king who had built himself palaces, cathedrals, mosques and minarets, mighty wharves and terraces all of this fairy cloud stuff." [1]

When children have spent enough time in general experience of the sky, actual and vicarious, to become awake, receptive and inquiring regarding it they are ready for the consideration of facts concerning the atmosphere and the phenomena which it produces or promotes. The following outline of topics has been evolved from atmosphere study:

The earth's atmosphere: its extent, composition and properties

Moisture: evaporation, condensation and precipitation The moisture cycle Clouds Snow crystals

Winds: classification Storms The wind cycle The work of wind

Fire: its cosmic aspect Flames, smoke

Winged life, with reference to individual, flock and migratory movements

Summary of atmospheric effects

Scientists tell us that the people of the earth are surrounded by a vast ocean of air which is subject to the same types of movements which affect the aqueous oceans; that this air serves the earth by retaining and modifying solar heat, absorbing and distributing moisture, and providing animals with oxygen and plants with carbon dioxide. The composition of the air, and its properties of density, elasticity and weight are subjects which little children perhaps cannot grasp except in the most general way. But they can reach some simple conclusions about air merely by blowing up a paper bag, a balloon, or a bicycle tire; by observing a barometer and having the principle of its action explained to them; [2] by contrasting their sensations in a close room and in one that is ventilated; and by noticing and feeling the effects of wind.

---

[1] J. B. G. D. in The Christian Science Monitor.

It helps children's concept of the earth's enveloping atmosphere to know that it is accorded the shape of an oblate, or flattened, spheroid, the oblateness of which is greater than that of the earth. They can learn that science concedes more than a hundred miles of height from the earth's surface to the outer extremities of this atmosphere.[3] Children who are familiar with illuminating or fuel gas are accustomed to the idea of an invisible entity called gas which has definite, recognizable properties. Thus without going into the chemistry of air, they have been able to grasp the fact that the atmosphere is composed principally of two gases in combination and of water vapor and dust.[4] That they might realize the volume of dust in even apparently clear air, light has been let into a darkened room through a small hole or narrow crack. In the slender beam thus produced the dust particles are readily seen. Such particles play an important part in that they scatter the light of the sun. Without the dust of the atmosphere shady places, we are told, would be in darkness; the sun would probably shine out in dazzling brilliance from a black sky; the stars would probably be visible even in the daytime. The blue of the sky and sunrise and sunset colors, the children have learned, are determined and produced by the dust of the atmosphere.

---

[2] See Rollin D. Salisbury: Physiography. p. 582.

[3] See same. p. 508-510.

[4] See Rollin D. Salisbury: Physiography. Part 3, Chap. XIII.

Moisture

Evaporation, the process whereby moisture is taken into the air as water vapor, has been demonstrated by exposing to the air a little water in a saucer or by hanging a wet towel on a line to dry. The principle of evaporation has been seen to extend to water anywhere exposed to the atmosphere; on leaves or on concrete pavements after a rain, in a pond or in an ocean. Condensation of water vapor has an example at hand when the damp, relatively warm air of a room condenses on the cold window pane or on the outside of a glass of ice water. From this start children have been able to get some comprehension of other products of condensation: cloud, fog, rain, snow, sleet, hail, dew and frost.

Cloud and fog are the same phenomenon, but fogs occur in a lower part of the air.[5] Fogs are really clouds resting on the surface of the land. Clouds assume many forms—among them cumulus, stratus, nimbus and cirrus. Illustrative charts of these can be obtained on request from the Hydrographic Office of the Navy Department, Washington, and from the United States Weather Bureau. Children have enjoyed discovering in the sky these easily identified shapes; and they have found them an inspiration to the making of intelligent paintings of cloud character and loveliness. Cloud photography by children has sometimes been surprisingly successful, even with a small snapshot camera. Cloud mirrorings in pond or brook or in sidewalk depressions after a rain have been beautiful experiences in which the cloud and sky colorings seem to be intensified.

---

[5] See W. J. Humphreys: Fogs and Clouds. This book is amply illustrated with photographs. Salisbury: Physiography. pp. 574, 576-580.

The condensation of water vapor in clouds may lead to precipitation as rain, snow, sleet, hail. To produce these the particles of water must be heavy enough to fall; and if they are to reach the earth they must pass through air which is not dry enough or warm enough to evaporate them before they get there. The temperature of the air at different stages of the journey decides which of these products will result.[6] When children have understood the continuous story of evaporation, precipitation, and then a repetition of these, they can understand how it can be that "all the rivers run into the sea; yet the sea is not full; into the place from whence the rivers come thither they return again." [7] This is the great moisture cycle.[8] A wide view of its work would make it responsible for a large share of the surface changes continually going on in the earth; for it contains the sequences that make the running water and the rivers, which in turn effect erosion, transportation, and deposition in the sea. Children have been helped to get the whole cycle clearly in mind and to retain it by drawing a pictorial chart of the principal sequences which makes it, and they have called it "From Cloud to Cloud."

The beautifully crystallized forms of snowflakes are well worth special attention.[9] The transiency of snowflake beauty has created some difficulty in children's initial observational experience. But as soon as they really know what to look for, they have seen the forms with ease. A hand magnifying glass

---

[6] Regarding rain, see W. J. Humphreys: Fogs and Clouds. pp. 72-75.

[7] Ecclesiastes I: 17.

[8] The steps in this cycle are described by Rollin D. Salisbury: Physiography. pp. 80-83, 114-117, 566.

[9] See W. J. Humphreys: Fogs and Clouds. pp. 67-69.

Courtesy of Nature Magazine

A SPIDER WEB JEWELLED WITH DEW-DROPS

is an almost indispensable aid. It brings out beauties and intricacies unguessed from the natural view. Snowflake seeing, like kite flying, can be done only in its season, regardless of the time of year which may be assigned to atmosphere study. And there are some snowy days which provide conditions especially favorable to the forming and preserving of crystals. When such rare times come it has seemed worth while to drop all things of lesser importance and fully enjoy snowflakes at their best. Children have made interesting, skillful and effective drawings of remembered snow crystals, using white chalk, or white paint with a minutely fine brush, on a black background; they have also drawn a variety of crystals of their own invention, adhering always to the structural rule of six.

Dew and frost are different from rain and snow in that they do not fall. They are a condensation of the water vapor of the air, but not a precipitation. The condensation on the glass of ice-water in the warm room is also an example of dew. It sometimes happens that the temperature of the surface of the land, or of the objects upon it, becomes lower than the temperature of the surrounding air; in such cases moisture collects on the ground or the objects. In the out-of-doors children are accustomed to recognize dew as shining globular drops, looking like so many diamonds in the early morning sunshine. They have discovered the reflecting power of dewdrops and their exquisite decoration of a spider's web or a leaf. Frost, which is condensation at a lower temperature than dew, they have learned to look for on window panes in recurrent forms of ethereal beauty; and they have known its fairy touch upon leaf and stick and spear of grass.

The discharge of electricity known as lightning is an accompaniment of vapor condensation under certain conditions;[10] the thunder is a noise due to the vibration of the air, which electrical discharge has occasioned. Children's interest in flash and streak and other manifestations of lightning, and in counting seconds between the lightning and the subsequent roll of thunder, has often diverted them from being disturbed thereby. In his poem The Cloud, Shelley provides an adequate and beautiful summary of the story of moisture including a reference to these; and he brings out clearly those principles of governing order and cyclic change which nature manifests in this instance as in others:[11]

I bring fresh showers for the thirsting flowers,
  From the seas and the streams;
I bear light shade for the leaves when laid
  In their noon-day dreams.

. . . .

I wield the flail of the lashing hail,
  And whiten the green plains under;
And then again I dissolve it in rain,
  And laugh as I pass in thunder.

. . . .

Sublime on the towers of my skiey bowers
  Lightning my pilot sits.
In a cavern under is fettered the thunder,
  It struggles and howls at fits.

. . . .

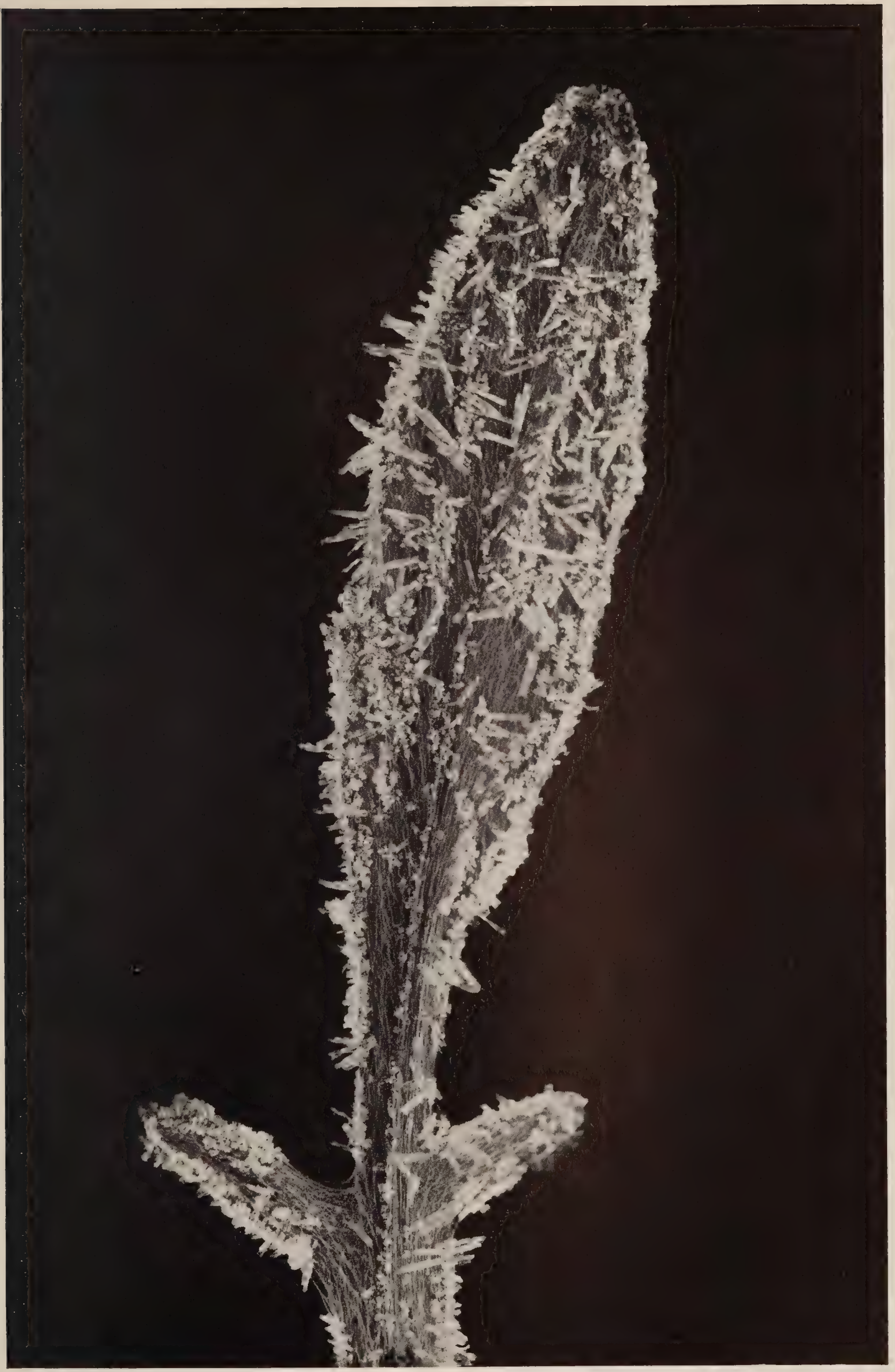
I am the daughter of Earth and Water
  And the nursling of the Sky:
I pass through the pores of the ocean and shores;
  I change but I cannot die.

. . . .

---

[10] See W. J. Humphreys: Fogs and Clouds. pp. 92, 93.

[11] See A. N. Whitehead: Science and the Modern World. The Macmillan Co., 1925. pp. 118, 119.



Cornelia Clarke

FROST CRYSTALS ON A LEAF OF BACHELOR BUTTON. ENLARGED

Wind

Wind is air in motion. The prevailing westerlies and the trade winds have been called great rivers of air in the atmosphere, greater than the currents of the ocean but moving on their courses with equal systematic precision and in obedience to fixed laws. "The wind goeth towards the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits" [12]—another instance of cycle. The Handbook of Nature Study contains an explanation of the cause of the motion of the air in general which is simple and clear; also an explanation of the specific motions which the westerlies and trade winds exhibit.[13] Children who have learned about the rotation of the earth have a basis for understanding this westward and eastward deflection.[14] A chart of the winds which children can readily understand is to be found in Compton's Pictured Encyclopedia; [15] and the correlative text brings out the usefulness of trade winds to navigation.

This knowledge has fastened itself in children's minds more securely when they have drawn it upon a map of their own; but it has not been put upon their plasteline wall map which was made to represent the earth's surface features. The air currents, if put on this map, would have looked like ocean currents, and the two phenomena might have lacked clearness of distinction in the children's thought. A clear, interesting way of superimposing map location facts is provided by the stereopticon lantern. An outline map of the world or some part of it can be thrown by the lantern upon a blackboard, and a tracing of it can be made which will remain upon the board when the slide is removed. Then other slides, made to fit this outline, can be shown on the blackboard in succession. These homemade slides can of course show any topographical facts which it is desired to portray. They are also useful in showing relationship if they are placed one upon another. A standard carrier will hold three slides superimposed.

---

[12] Ecclesiastes I: 6.

[13] Anna B. Comstock, p. 866.

[14] See Schuchert & LeVene: The Earth and Its Rhythms. p. 8.

[15] P. 1351.

It has seemed unnecessary for little children to go very far into the subject of wind movements; but it is important that they should know that the winds follow definite courses for logical reasons, and that they illustrate the order of the cosmos which every phase of natural study reveals. A classification of winds according to strength and velocity has been made including calm, breeze, gale, storm, and varieties of storms. Their own experience provides to children illustration of most of these. Cyclone, whirlwind, tornado, and waterspout provide interesting study of a fundamental movement in nature, the spiral.[16]

The rocks, the forests, the waters of lake and sea are acted upon by the wind with far-reaching result, as study of the earth's surface has already pointed out. Windmills, threshing fans, sailboats and iceboats are man-contrived devices for capitalizing wind action. Beside these, there is a wide range of wind playthings existing for children's delight. Children's invention in pin-wheels, large and small, simple and complex, adventurous in color, may know no bounds. They have also made other wind playthings such as toy sailboats, toy weather vanes, kites, Æolian chimes and wind harps.

A fascinating experience for a group of children, and a most attractive sight for onlookers, is that of playing out-of-doors with gayly colored gas-filled balloons like those referred to in connection with the illustration of planets. At first the balloons have been held by cords to keep them from escaping; but when the time comes to let them go free, and they sail far up and off in the ocean of air, the most intriguing part of the experience is reached. For as these brightly colored translucent spheres lose their brightness and grow smaller and dimmer with distance, and then merge with the sky to be seen no more, imagination follows them irresistibly on and on into space.

---

[16] See Rollin D. Salisbury: Physiography. pp. 648, 666-673.

An experience which is so worth having that an effort should be made to achieve it, is that of seeing a balloon man, the kind who haunts the edges of a circus or foot-ball game or the side-lines of a parade, with his tugging swarm of a hundred balloons or more. Their translucence, shine and color attract first; but the real fascination lies in their vibrating movement and tension, and the entrancing play of the light as it shifts, gleams and glances through the whole moving mass.

Kites have provided an experience somewhat similar in value to that of balloon flying. But since kites can be made by children they offer an opportunity for much scientific and artistic experimentation in size, shape, material and decoration. A kite-flying contest, with recognition of flying, originality and beauty, is such a delightful pastime for old and young that it has invariably captured the interest and participation of fathers as well as children. A group of children on the day following such a contest, recalled thus their impressions of the winning kite: "It looked like a little dot of a kite, way up in the sky, with miles of string up to it. It was grayish white like the clouds, and far up in the sky it looked like a bit of sky itself. I think it went six balls of string high. Some children holding the string were doing the Charleston and it seemed as if the kite was doing the Charleston in the air. Then sometimes they jerked the string and said, 'How do you do?' and the kite said, 'How do you do?' back again. When the string broke it was like a comet letting go of its gravitation and flying off into space."

The beauty and prevalence of wind-caused movements are not lost upon children. They have noted the swaying of branches, the nodding of wayside flowers and grasses, and the interwaving of reeds. They have watched with interest the way in which dry leaves are blown along and swirled; they have appreciated the description which this writer has given: "Then the wind goes round and round the house, looking for the leaves—for the wind is a bit of a nursemaid—and wherever it finds them it tucks them in, under fences and up against cellar windows where they will be safe until morning." [17] They have discovered the spiraling movement of a tiny dust whirl, and movement manifestations even slighter than this. A little boy wrote, "The wind came out and he didn't see the snowflakes. But all of a sudden he did. He saw them just as they had fallen down and he blew them up again." The wind has provided abundant opportunity for representation in rhythmic pantomime.

Fire

Fire has played an important part in cosmic evolution, and it has been found necessary to our life upon the earth. Therefore the study of the earth as a whole could not leave it out. It does not, strictly speaking, belong to the subject of the earth's atmosphere. But since the oxygen of the air is necessary to the occurrence of fire, this topic has been considered in connection with atmospheric study.[18] Oxygen does not mean much to little children; but they are convinced that air is a necessity to fire by the simple experiment of taking the air away from a lighted candle by putting a tumbler over it. Primitive modes of producing fire by means of rubbed sticks, the striking of flint, and sun heat focused with a lens, have always been interesting to children. The experiment with the sticks, in which much energy is required to generate the heat, has made a good opening for explaining to children that the ignition point is relatively high; the chemicals on the end of a match they can see have a low point for combustion is started with the slight effort needed to scratch it.

---

[17] Charles S. Brooks: Journeys to Bagdad. Yale University Press, 1915. p. 52.

Children have found it arresting to learn that a substance which seems to pass out of existence with burning does not really do that; but, instead, it provides an example of the conservation which is a law of nature. Nothing is really lost. A chemist can burn a weighed piece of wood, and then find with no loss of weight all its original elements represented in water vapor, carbon dioxide, and ashes.

Fire is a beautiful phenomenon; but our awareness of its destructiveness may sometimes make us fail to realize that children can enjoy fire in many safe and interesting ways. The woodcraft of making and extinguishing fires even little children can have some part in. An open fire in the woods or on the hearth has unique powers to bring together and centralize a group, and it offers to the solitary watcher a special fascination. A coal fire has furnished the imagination of children with radiant little caverns and castles glowing white and crimson; a wood fire snaps and crackles, and invites their discovery of grotesque faces and shapes.

---

[18] For information of combustion, flame and smoke, see Carleton W. Washburne: Common Science. World Book Co., 1927. pp. 312-319.

Woods camp fires after dark have had added attractiveness when dead pine branches have been burned, for the needles glow brightly and for an appreciable time retain their shape. The burning of an autumn pile of leaves gives interesting flame formations and movements. Driftwood fires on a beach have been a glorious experience because of the energetic fun of finding and gathering the wood along the shore in the wind; and they have provided further pleasure if the substances the wood contains have made the flame more colorful. Children's pleasure in color has been amplified by adding chemicals to a fire, strontium nitrate for red, potassium nitrate for purple, copper sulphate for blue and green, barium nitrate for green, and sodium nitrate for yellow. A beautiful way of playing with fire is provided by ordinary sticks or joss sticks, in the darkness of night, especially around a camp fire. When the tip ends of these sticks are burning with a tiny glow without flame and the sticks are waved and gyrated, endless formations of geometric character appear in the aspect of moving lines of light—zigzagging, curving, intersecting, according to the will of the holder. The creative ingenuity of children, dancing or sitting still as they choose, has made of this a fascinating occupation. Another experience, which should find its way into the period of childhood at least once, is that of professional fireworks. These, if they are of the right sort, can give rare demonstrations of luminousness and color and unimpeded rhythmic movement. Pinwheels, rockets, Roman candles and pyrotechnic wheat and fountains are among those most worth seeing.

Flame and smoke have been explained to children in a general way. They have been told that all flame is evidence of the burning of released gas, just as truly as in the case of the burning flame of the gas stove; that smoke is evidence of burning particles of matter that are not consumed by the flame. The movements of these, so fitful in the case of flame and so continuous and rolling in the case of smoke, and their ever-changing shapes, are factors which have easily made themselves known. City children especially have opportunity for smoke observation. The successive gray-white image-forming puffs of a tug-boat; the black column that rises from steamer smokestack or factory chimney to spread, diffuse and float off in the air; the black and gray billows that surge out and stream back from a fast flying train or the ethereal blue curling wisp that a dwelling emits are all or in part at hand for everyday contemplation. Flame and smoke in their movement mean most to those persons whose sense of rhythm has been developed; and they invite representation in rhythmic dance and pantomime. The colors, forms and movements of flame and smoke seek expression, too, in a graphic way. Pastels and colored chalks have proved the best media for this, for children.

Winged Life

Winged insects and birds have been considered in the study of the atmosphere from the standpoint of flight. As beasts and creeping things belong to the land, and fish to the water, so winged life belongs to the air. The moths and the butterflies, the bees, the fireflies and certain birds have been familiar, to suburban children at least, from earliest years. The beauty and variety of moths and butterflies and the possibility of living with their development from the cocoon stage are experiences open to all.[18a] A little boy who watched a newly hatched moth spread its wings for the first time and after a few little movements on the window-sill fly high up into the blue, and off, with grace and ease and sureness, showed wonder and admiration as well as modernity in his remark, "What a take-off!"

Children who have become interested in the flight of moths and butterflies are not likely to have the desire to kill them and impale them on pins for exhibition collections. This interest they have found shared in Japanese poems.

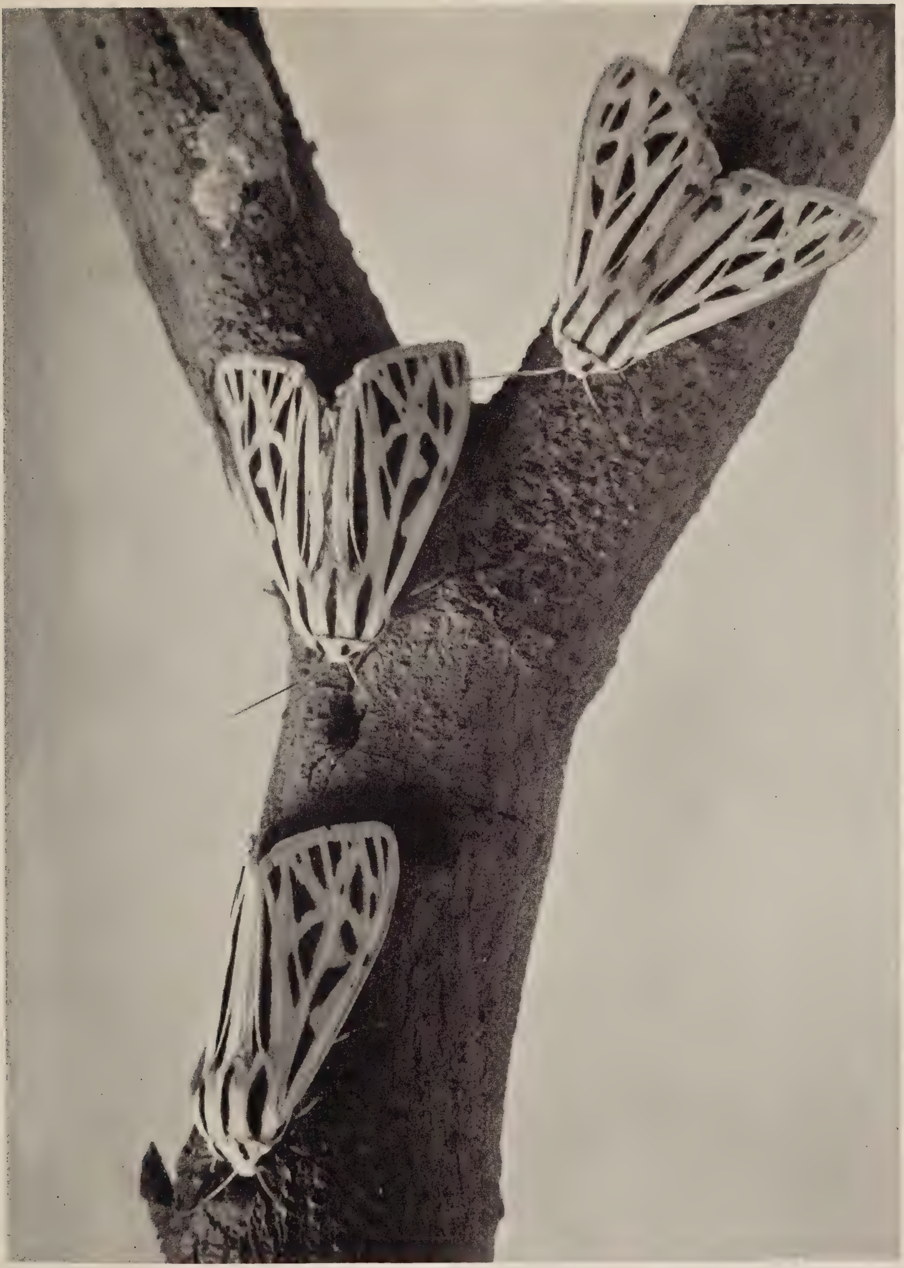
> Fallen flower returning to the branch.
> Lo! 'tis a butterfly.
>
> See that butterfly on the woman's path
> Now fluttering behind her, now before.
>
> Ah, little butterfly!
> Even though chased, it never seems in a hurry.

The first one has a counterpart in the description of the young deer Bambi[19] who, in the first summer of his life, thought the butterflies were flying flowers.

I have found that children who know well the colorings of their neighborhood birds, and even the song, may have only a vague notion of the specific movements which characterize them. Once observation is started in this field, however, it goes on by its own momentum. The redwing blackbird children can notice has a strong, swift, non-soaring flight. The crow, in a flock of his kind, circles and sails for a short

[18a] Cocoons can be obtained from Edward Weidenhammer; 213 Calhoun St., Baltimore, Md.

[19] See Felix Salten: Bambi. Simon and Schuster, Inc. p. 34.



L. W. Brownell

THE LITTLE TIGER MOTH IS A HANDSOME CREATURE, BOLDLY DESIGNED IN BLACK AND WHITE

distance when inspecting the ground, but does not soar as the hawk does. At other times he progresses in a straight direction, straight as a crow flies, it has been said. The hawk and the buzzard with great motionless, outstretched wings soar in wide circles, high in the air, seemingly immune to fatigue. The little swifts, often mistaken for swallows, are motionless flyers too. After a few initial strokes of their pointed wings they move rapidly, seeming able to go on endlessly without any apparent effort. A martin attains a high point of the sky and then suddenly seems to drop, straight down. The pigeons circle, sail and alight in a flock, and repeat these movements day-long in unfailing successions.

Even city children can see flocks of pigeons, watching them rise and wheel and drop in unison, their wings now darkly and sharply outlined in shade, in the next turn gleaming white in the sunshine, then for an instant almost blotted out as they are merged with the light. The meadow lark lifts itself with sharp movements, and then skims smoothly in low course over the fields. Wild geeze flying together in wedge-formation, with powerful wings and "necks astrain," as Masefield says, are not within the observation of all. But their flight is so interesting, individual and beautiful that it is worth while to try to communicate an impression of them through the experience of others.

Benson's etchings of wild birds in flight, in their natural setting of reeds and rushes and marshy places, are a help to this end; so also, for children, is the imaginative, but basically true, concept of the gander and his flock in The Wonderful Adventures of Nils. Whitman writes, "The wild gander leads his flock through the cool night. Ya-honk! he says, and sounds it down to me like an invitation." The common sparrow has what may be called an ordinary flight; but it can take one's breath away when suddenly it chooses, in mid-air, to reverse its direction. For an instant of time it seems perfectly still as if it could poise on nothing. The gulls in gray and white beauty "wing with the wind" [20] over wide spaces of sea or coast. To one watching them in a strong gale, they seem, after circling to a height with wide-stretched pinions, to make sport of letting the wind blow them sidewise, horizontal with the sea below; or they coast swiftly and obliquely down, seeming to slide on the air, and with perfect precision reach a morsel of food on the water. Or, solitary, with enormous stretch of wing and mighty strength, they go high and far, soaring with a turning movement, wheeling in great circles, gray against gray sky and shining white in the sun. The representation of a single gull in flight is provided in photographs sometimes obtainable in art stores and made by a San Francisco photographer. The bird which is credited with attaining the greatest height in flying is the little English lark. Unfortunately it cannot be seen in this country. Wordsworth's skylark poem has a lifting power which gives to one's inner consciousness some realization of what such flight must be.

Children, I believe, have a latent feeling of kinship with birds in their flying aspect. A writer in Bird·Lore is perhaps speaking of the attraction which underlies it when he says: "It was some time before I myself fully understood that it is not alone the song, form, coloring and the classification of birds, instructive and interesting as these matters are, that holds my interest. But it is what, for the want of a comprehensive word, I call the glad-free-life of the wild bird. This never fails to hail an element of myself that lies beyond my

---

[20] Wilfrid Campbell: When the Gulls Fly.

William L. Finley

GULLS IN FLIGHT

work-a-day thoughts. Wild birds in some way symbolize to me a life of more spirit and less clay, which I seem to have lost for the most part somewhere along the way, or perhaps that nature promised in full measure in youth but later in some indigent mood withheld. No other manifestation in nature or art so nearly corresponds to this eluding side of my life as the independent, songful life of wild birds." [21] A group of children were asked how they would like this world to be, if they could effect in it any changes they wished. In the replies of three out of seven children these statements were included: "I'd be like a bird and fly all over the world," "I wish we could fly wherever we wanted to go," "I'd like everybody to have wings."

The mechanics of bird flight have been described for children by a writer in the nature study field.[22] She explains the structure of wings somewhat, and shows that a bird flies by pressing down upon the air with its wings and thereby lifting itself. She tells something also of the size, shape and position of feathers, with relation to various types of flying. An interesting chart in color of the growth of a feather is supplied by the Perry Pictures Company. When children have turned their attention towards feathers, they make many discoveries of attractive and interesting form and of striking or softly beautiful color. Their walks in the moulting season have meant the finding of feathers. While those of wild birds may be scarce, the domesticated pigeons and the barnyard fowls are sure to make numerous and surprisingly varied and attractive contributions.

Sometimes the keeper of tropical birds in a city zoo has co-operated with a group of children by saving for them some of the gay, unusual little feathers which drop to the floor of the cages. In some zoos the peacocks are permitted to roam about the grounds in freedom. In such cases a hunt in their range has sometimes been rewarded with a beautiful little trophy of green and blue iridescence. Children naturally want to keep and continue to enjoy their collections of exquisite feather findings; and they have displayed them effectively on neutral backgrounds made with pastels. But unless some effectual insectide can be found for the feathers, their preservation and sometimes even their temporary retention is impracticable. Blue prints made from the feathers do not reveal their color but they preserve good impressions of form.

---

[21] Eugene Swope: Why Birds Interest Me. An article in Bird Lore, Sept.-Oct., 1921.

[22] Anna B. Comstock: Handbook of Nature Study. pp. 27-35.

One child's experiences with feathers are illustrated thus: "One day I picked up a feather and threw it up, and guess what happened! It came twirling and twirling and twirling down to the ground." And again, "I held a feather up to the big, round, red sun. The color of the sun came through and there was a rainbow in it, rainbow shaped."

The group movements of birds in going to roost or at other times during the day, and other instances of apparently instinctive movement responses, have been carefully observed and recorded by Burroughs. He says, "The concert of action among birds is very curious. . . . When they are on the alert, a flock of sparrows, or pigeons, or cedar-birds, or snow-buntings, or blackbirds will all take flight as if they were one bird instead of a hundred. The same impulse seizes every individual bird at the same instant, as if they were sprung by electricity. Or, when a flock of birds is in flight, it is still one body at will; it will rise, or circle, or swoop with a unity that is truly astonishing. A flock of snow-buntings will perform their aerial evolutions with a precision that the best-trained soldiery cannot equal. Have the birds an extra sense that we have not? A brood of young partridges in the woods will start up like an explosion, every brown particle and fragment hurled into the air at the same instant. Without word or signal how is it done? . . . When any of the winged creatures are engaged in a life and death race . . . the flight of the two is timed as if they were part of one whole. A hawk will pursue a sparrow or finch through a zigzag course and not lose a stroke or half a stroke of the wing by reason of any darting of the prey to the right or left. The clew is held with fatal precision. No matter how quickly or how often the sparrow or finch changes his course, its enemy changes, simultaneously, as if every move was known to it from the first. The same thing may be noticed among the birds in their love chasings; the pursuer seems to know perfectly the mind of the pursued." [23]

Chapman has given special attention to the orderly formations which birds sometimes assume. Of gulls he says, "At times they fly in even rows, perhaps half a mile in length but not more than three or four gulls deep. Or they may come home in V-shaped flocks with as many as seventy-five or a hundred gulls in each arm of the V. But whether in long billowy lines or even flying wedges, the flights of the gulls teach us in what orderly manner the gulls perform these little journeys." [24]

Regarding flock movements in general, Burroughs says it is his belief that "out of the flocking instinct there has grown some other instinct or faculty, less understood but equally potent, that puts all the members of a flock in such complete rapport with one another that the purpose and desire of one become the purpose and desire of all. There is nothing in this state of things analagous to a military organization. The relation among the members of a flock is rather that of creatures sharing spontaneously the same subconscious or psychic state, and acted upon by the same hidden influence, in a way and to a degree that never occur among men." [25]

---

[23] Riverby. Houghton Mifflin & Co. pp. 200, 201.

[24] Travels of Birds. p. 24.

The migration of birds is perhaps the most arresting fact concerning them. What law of unanimity or what other cause lies beneath the ability of birds of a kind, starting from points many miles distant, to begin on an identical day their great journey to other climates? Of the application of this phenomenon to swallows, Chapman says, "How can they know when it is time for them to start? Who can say? But that they all know, it is certain. On that day all the swallows which have been roosting within miles of each other rise up in the air together. From a distance they look like a snowstorm of great black flakes. . . . The great day has come!" [26]

On the same subject J. Arthur Thomson says, "Let us recall for a moment just one of the wonders of animal behavior—the wonder of migration. . . . What journeys they take—the Arctic tern was found by the Scotia explorers in the Far South. How swiftly they fly, how confidently across the pathless sea, at night, at a great altitude. How strange that young birds usually fly away first in the autumn without waiting for those who have made the journey before. How striking the fact—proved for some birds—that they may return from their winter quarters to the garden where they spent the summer." [27]

---

[25] Ways of Nature. Houghton Mifflin & Co. p. 98.
[26] Travels of Birds. p. 22.
[27] Bible of Nature. p. 24.

Bird-banding, the method by which the travels of individual birds are discovered and bird routes are helped towards establishment, is an interesting subject for study. Observations extending over nineteen years have proved that banding is not injurious to birds and that it does not disturb their habits.[28] Known routes of bird migration, some of them more than 5,000 miles long, are shown graphically in Chapman's Travels of Birds. These can make a profitable and interesting study for children; and they can be represented on the children's relief map of the world if the clearness of the map is not jeopardized thereby. Bird journeys across seas from continent to continent have served as one more illustration of the basic oneness of the earth; also of adaptation in function and instinct to meet conditions of living.

In the study of the whole subject of the earth's atmosphere there has been opportunity to bring children into further realization of ways in which cosmic conditions affect our earth. The movement of the winds with reference to the earth's rotation has illustrated this; so also has the migratory habit of birds with reference to seasonal changes wrought by the earth's revolution. Interrelations and interdependencies have been brought out, in that the air retains and modifies solar heat; the dust of the earth's surface, transported and largely produced by the wind, scatters and diffuses sunlight; and the air supplies oxygen to animals and carbon dioxide to plants. Two great cycles are included: the moisture cycle which has revealed the transformations of water and important relationship to the earth's surface changes; and the wind cycle which is a cycle of movement in a course.

---

[28] Stated in press report of an address of Dr. Theodore Jahrens before the 40th Annual Congress of American Ornithologists.

The study of moisture and the study of fire have both brought revelation of nature's conservation—the law that though substances change, they cannot be lost. The order which prevails in the natural world has found its example in the fixed rules governing evaporation and precipitation, and a substance's point of ignition; it has been shown also in the crystal forms of snow-flakes and in the flocking and migrating habits of birds. Wind, water, cloud, flame and smoke, and birds have brought added realization of the rhythmic aspect of natural movements.

VII.

Beauty and Rhythm

THIS chapter makes adults' rather than children's thought the chief objective. Much of the material it presents is appropriate for children and has been the basis of work with them; yet it is not thought of as subject matter to be taught or introduced. The primary purpose of the chapter is to recall or bring to the parent, teacher or other person associated with children certain ideas regarding beauty and rhythm. It is believed that these ideas can help to provide the kind of environment which will arouse children's thought; also that they can promote on the part of adults responsiveness to interests of children which right environment will surely uncover. And the response of adults will help to carry these interests further. The only teaching which this chapter recommends specifically is that which provides training for children in fundamental rhythmic movement.

Beauty is one of the means whereby, at times, we may seem to glimpse reality. It is J. Arthur Thomson's view that "man's joyous drawing toward the beautiful may express a harmony that goes very deep into the meaning of all things"; [1] and he quotes P. Chalmers Mitchell as saying that esthetic emotion is the responsive thrill to creation realized.[2] To become truly conscious, for a moment, of the intrinsic beauty in some natural experience is perhaps for that moment to see gates of revelation part and to feel a oneness with the universal order. The universal aspect of beauty links it to reverence; it also links it to joy. The experience of beauty often brings one to silence; but just as often perhaps it is responded to, in one's inner consciousness, by something that is akin to soaring, cosmic song.

---

[1] The System of Animate Nature, vol. 1: Henry Holt & Co., 1920.

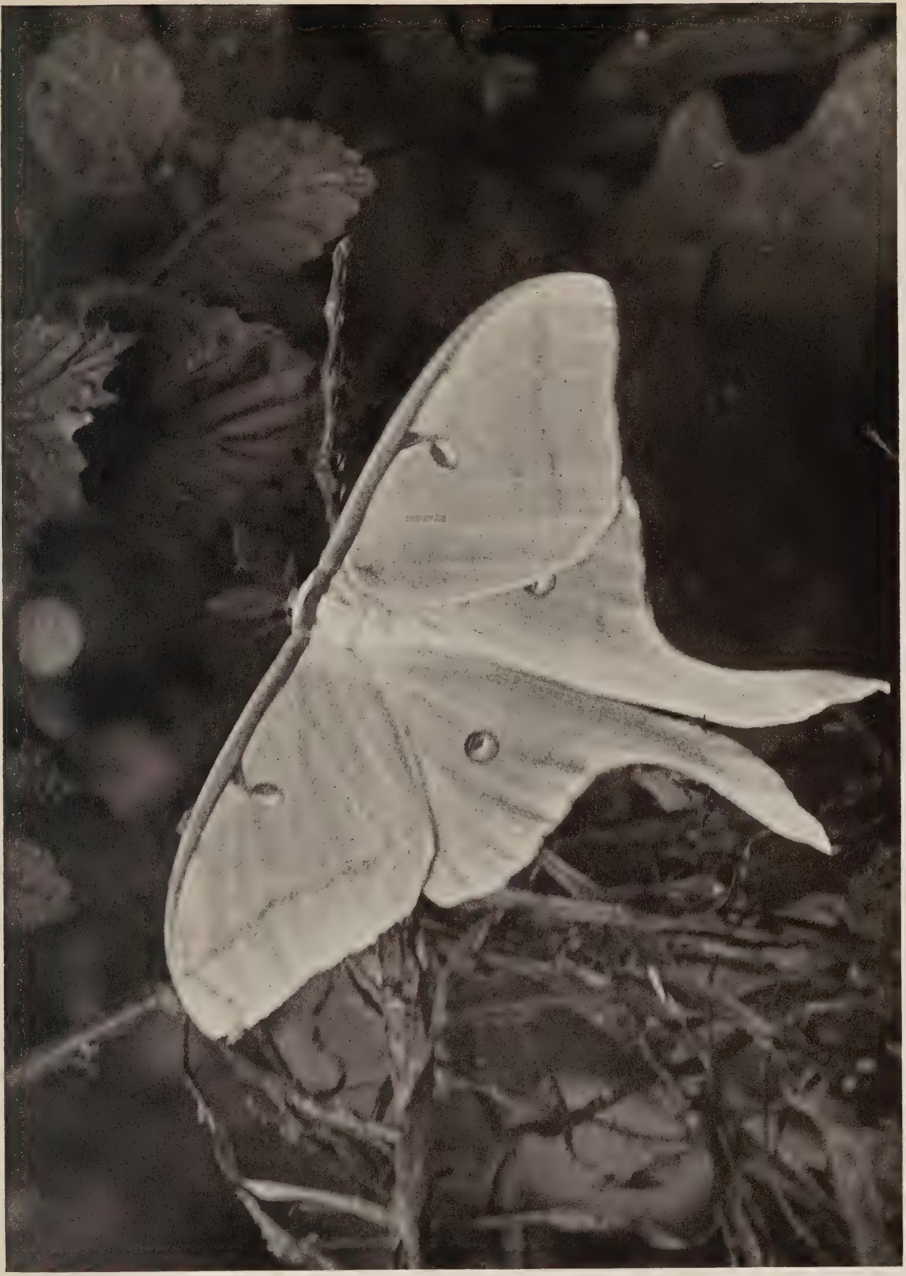
[2] See same, p. 279.

John Burroughs says, "It is out of a certain harmony of the elements that we arose, and our sense of beauty was developed"; [3] and Denman W. Ross says much the same thing.[4] The beauty of the natural universe is a beauty of order; all the knowledge we gain points to this. Children as a group, more reliably than adults perhaps, respond to illustration of the factor of the universal in beauty. They give evidence of this through reverence, joy, and a democratic desire to share with others the experience they themselves are having. Beauty, in its universal aspect, becomes known to children partly through intuition and partly through such knowledge and experience of natural objects and events as may have come to them. The development of the consciousness of rhythm, discussed later in this chapter, is another means to this end.

Due to the influence of their mental environment, boys above the age of eight have occasionally, in my experience, allowed a very real sense of beauty and poetic imagination to be invaded with the thought that its expression would be unmanly. When they desire to state something which they feel or think, they may preface it by saying, "When I was little, I used to think." The truth may be that they are stating a present experience which they are unwilling to acknowledge. When children of this type come into the realization that beauty pervades all of nature known to them and that it is illustrated increasingly as the wonders of the natural world unfold about them, they tend to lose this false valuation.

---

[3] Accepting the Universe. p. 77.
[4] Exhibition Pamphlet: Century Assn. of N. Y. Nov., 1923.



L. W. Brownell

THE EXQUISITE LUNA MOTH. THE COLOR IS PALEST GREEN

The universal aspect of beauty insures it to all. There need be no special grace of seeing; no special age, time, place or event. Beauty is a possession; but its possession is not exclusive. In individual experience it grows with sharing. It is common language to all who respond to it. The apprehension of beauty, for any one, makes for enlarged individuality. Real beauty can speak to consciousness with a force and a meaning which do not wane. "A thing of beauty is a joy forever," Keats said; and his expression can no more become trite than the idea which it announces. All these facts regarding beauty, it may be conceded, have a basic social value in the education of children; and they have their part in making an individual finer and in adding to his mental resources. Awareness of beauty should make all living keener and it should lead one to find unfolding pleasures in even the most ordinary nature experiences in everyday existence.

Children should be educated in beauty but should be, I believe, largely self-taught. This teaching should come through observation and absorption, the adult's chief responsibilities being to see that the children's environment holds contacts and experiences that can yield natural beauty; also to share with honest responsiveness their growing delight. Early impressions persist and not only become a resource for later years, but they help to form the individuality that is manifested in those years. Walt Whitman says:

There was a child went forth every day;

And the first object he looked upon, that object he became;

And that object became part of him for the day, or a certain
part of the day, or for many years, or stretching cycles
of years.

The early lilacs became part of this child,

And grass, and white and red morning-glories, and white
and red clover, and the song of the phœbe-bird. . . .

And the apple trees covered with blossoms, and the fruit
afterward, and wood berries, and the commonest weeds
by the road. . . .

And all the changes of city and country, wherever he
went. . . .

These became part of that child who went forth every day,
and who now goes, and will always go forth every day.

Truly natural surroundings can take care of all needs. But when these seem unattainable, pictures can help. Those pictures mean most which seem to have a touch of the infinite in them; which illustrate the operation of natural law, or carry a suggestion of cosmic happiness or peace. A picture may be very simple and childlike and yet be potent to supply the kind of beauty which gives thought wings and releases imagination. A group of children in an institution was asked to suggest subjects for pictures about to be purchased. Among the suggested subjects the following were included: Night and the stars, a gateway and a pathway of flowers seen through it, a mother and a baby, trains going at night, a little house in the mountains, a mountain reflected in water, things seen through an arch of a bridge, Hiawatha, buildings lighted up at night, a lighthouse, the sea and ships, a shepherd and sheep, children playing.

In the realm of beauty much can be experienced from what may seem very little. Whitman has said that the running blackberry would adorn the parlors of heaven. A few square inches of lawn, field or woods may reward the seeing searcher with many real experiences of beauty in form, design, color and movement, as suggested in a preceding chapter. Chiaroscuro may play its interesting game with even a single city tree. A kitten has the grace if not the majesty of a tiger. From a tall building or a hill the whole dome of the sky may stand revealed. One's experience of beauty in all this is the sum of esthetic meaning it conveys; it is not the relative size, multiplicity or complexity of the objects. This is legitimate consolation; yet I would not think of implying that magnitude, space and physical setting do not illustrate to our consciousness certain definite values that seem to be arrived at materially by no substitute means. The following lines in which a feeling for space is a factor were spontaneously produced by a boy of eight. If he had known the word infinite probably he would have used it; but he has employed the term miles to convey the same thought. How I'd Like the World to Be, is the title.

Not all city!
Not so hard
Nor civilized
But country around for miles.

Wild things growing
Everywhere.
Farm houses near and far
Little birds to rest their young.

Robins chirping
Bluebirds building
Everything woodsy
Nature hath grown.

Gardens of flowers
Growing all round

Miles of pink sky
Forever it runs.

Country for miles
High peaks and low
Nothing but nature
Has done to this world.

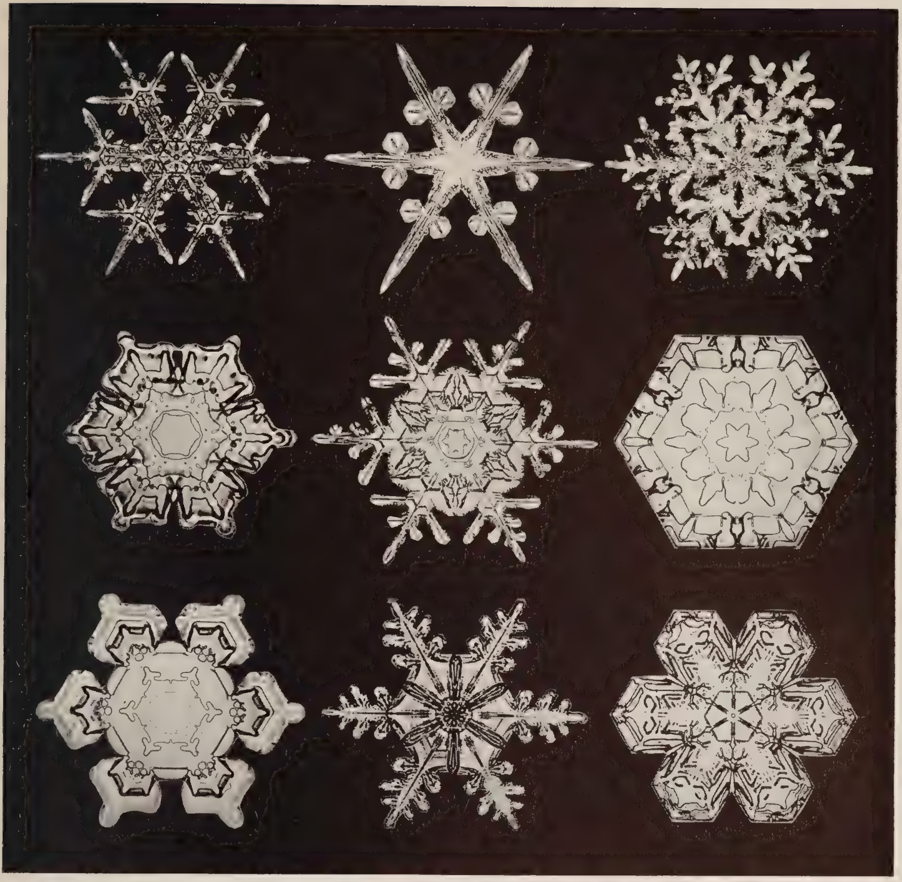
Rivers and ponds,
Lakes and streams
Run for miles
And joyously sing.

Beauty is essence. The essential qualities which we sense as beauty are manifested through various media. Thus when we see or feel resemblances, in our experiences of beauty in the natural universe, we are noting repetition of some essential quality which we respond to and have come to recognize. As our store of experience grows nature seems to abound the more in such resemblances. From our perception of essential quality the use of simile is born and powers of imagination are developed. Mr. Thomson quotes Professor Bosanquet as saying, "Man is not civilized, esthetically, till he has learned to value the semblance above the reality. It is indeed, as we shall see, in one sense the higher reality."[5] It includes analysis and steps of appreciation beyond perception.

Anyone who works with children is likely to note how readily they see the more obvious resemblances in the nature world. To them a sunflower is like the sun, Queen Anne's lace may suggest a star cluster, the branching veins of a leaf provide the form of a tree. The markings of a shell suggest clouds, or certain rounded fungus growths remind them of

---

[5] The System of Animate Nature. p. 270.



Wilson A. Bentley

SNOWFLAKES IN THEIR ENDLESSLY VARIED DESIGNS KEEP TO THE NUMERICAL PRINCIPLE OF SIX

the forms and colors of mountains; the dried calyces of field asters seem to be some exotic variety of woody flowers; certain flowers look like birds, certain crystals look like flowers. These illustrations, though based on some apparent likeness of form, coloration or texture, are entirely apart from the resemblances in nature which science ascribes to the purpose of protection. But there are resemblances much more subtle, based on the essential qualities of things more than their external character, which children seem able to discern. They have sensed an analogy between the catlike grace of an animal and the flowing of water; and they have been aware of a common factor, perhaps etherealness, evanescence, in the photographed appearance of a comet and the globe of a blown dandelion.

Children evidence their capacity to note essential quality by the similes and metaphors which they use in their speech and their writing. A little girl of five said of piled up white clouds, "It's snow"; of tiny cascades, "It's bumpity, bumpity, bump." Another said of a rocket, "It went up like a fountain shower of fire." A little boy described a comet, "with its tail torching out behind." Another wrote, "Clouds were moving slowly across the sky, like smoke from a fire in a gentle wind."

Revealing too are the words children coin, sometimes unconsciously, when no accepted expression is at hand to convey their meaning with the poignancy they desire. A little boy in writing of experiences in the woods refers to the "swusshle" of water. A little girl in a winter poem writes of trees "aglaze" with ice. This readiness of children to note resemblances gives them adventures in the field of imagination. Because of it they are able to see pageants in the sky created from moving cloud forms. In the gnarled and twisted branches and roots of trees, or in rows of tattered cornstalks, they see gnomes and grotesques like those which Arthur Rackham and some contemporary German artists love to picture in children's books. Of a poem like this, quoted in part, they have intimate understanding:

And before my way
A frowning thistle implores my stay.
What to others a trifle appears
Fills me full of smiles or tears;

For double the vision my eyes do see,
And a double vision is always with me,
With my inward eye 'tis an old man gray,
With my outward a thistle across my way.[6]

I find it is possible in talking with children to use the terms inward eye and inward ear and be sure they understand what is meant. Wordsworth's Poem of the Imagination (No. 12) is unfailingly a favorite, especially the lines:

For oft, when on my couch I lie
In vacant or in pensive mood,
They flash upon that inward eye
Which is the bliss of solitude.
And then my heart with pleasure fills,
And dances with the daffodils.

Beethoven's ability to compose beautiful melodies and harmonies even after the loss of his hearing may have depended largely upon his scientific knowledge. But Edward Carpenter, his biographer, said that the deafness increased his composing power, that it "left him fancy-free in the world of music." [7] It is possible to invoke impressions of beauty from children by asking them merely to close their eyes, or stop their ears, and wait receptively for a few seconds for whatever may come to their consciousness. If some sight or sound of beauty does come it can only be because it has at some previous time been part of their actual experience. Thus it follows that, as pointed out before, experiences of beauty have not only an immediate but a potential significance; they become part of the individual's mental resource, contributing to the quality and fullness of his life in any eventuation.

---

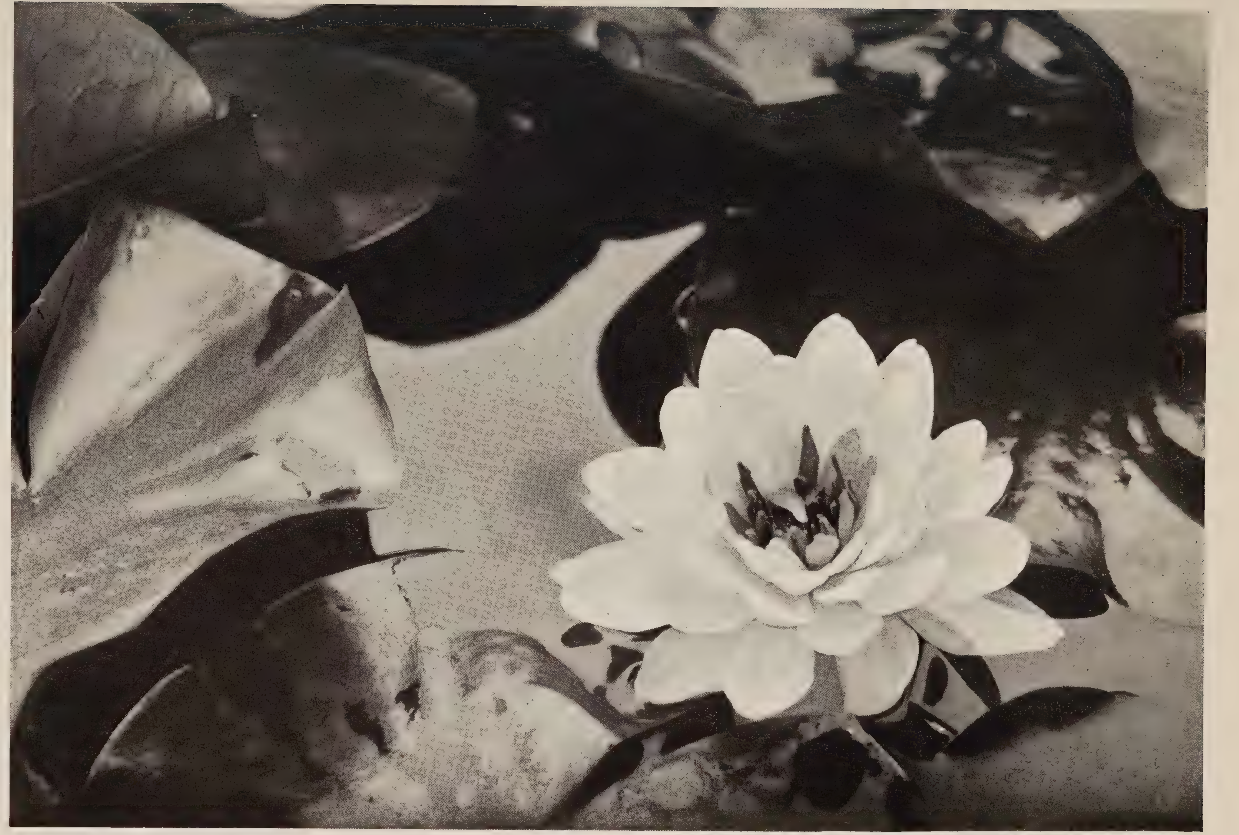
[6] William Blake.

[7] Angels' Wings. Sonnenschein & Co. 1898.

The capacity of children for storing impressions can be made the basis of their first work in English expression. It has been a common practice in my work, after first asking the children to be mentally alert with their minds emptied of transient thoughts, to announce to them some word, sometimes an abstract one, asking them to tell at once the spontaneous impression or thought it may have given rise to. This method was referred to in the third chapter of this book. I have, for example, proposed the word Distance. Among children's immediate responses have been: "A far star, shining brightly," "A long open field," "Space stretching forever." From the word Light have come: "A great spread of light from the sun," "A dark night, and people sitting around the fire," "The sun shining on all the worlds. They have one side dark and the other side light." From Beauty: "The big, round sun coming up from the ocean at Cape May," "The sun shining on the flowers in our garden last summer," "A pretty night, with the moon lighting up the edge of a cloud. The rest of the cloud is dark." From Flowers: "Wild flowers just opening after a rain. The drops are on them still," "Tulips in a garden, in a row, and all different colors." From Quietness: "The sun gone down behind a hill. The evening star just appearing," "The slow, silent movement of the earth turning round," "A quiet night." From Winter: "Animal tracks in the snow," "People having fun skating," "Snow on branches of trees making funny little shapes of houses and buildings," "A boy running up hill with a sled and a dog and it's snowing," "The sun shining on icy branches of trees," "A horse pulling children on a sled."

In some instances I have asked children to set down in writing what they have seen or thought, instead of telling it orally. This may be for them the initiation into written composition. The merit in the method is that children start with something to say; writing is not seen as a thing in itself but rather as a useful medium for expression. Sometimes in writing it occurs to children to add subsequent thoughts to the initial spontaneous ones. The total result may be a catalog but it is likely to make up in interest of content what it lacks in interest of form. The examples which follow illustrate.

From the suggestion Nature, a little girl of eight wrote this: "Flowers, brooks, trees, grass, woods, a river, crystals, copper, soil, the dew on flowers and dandelions, the grass all wet in the morning, the sun just coming up, flowers just starting to open, the hot sun shining and flowers drooping, the moon shining and stars all around." Another wrote from Beautiful Things: "Vegetables, flowers. A vine climbing up a tree. Cherry blossoms. Lots of spring flowers. A bush all over pink flowers. Another with white flowers. A hill, and on the hill one big tree. Morning glories. Little woods animals. The squirrels, the way they run taking long leaps from one tree to another. A brook running through the woods. The water coming to a rock and going right over it. A road, and by the roadside pretty flowers."



L. W. Brownell

THE WILD WATER LILY DERIVES ITS BEAUTY FROM THE PURITY OF ITS WHITENESS AND FROM THE DYNAMIC EFFECT DUE TO THE SPIRAL ARRANGEMENT OF ITS PETALS

Sometimes, in order to bring out awareness of the qualities of an object or experience, I have asked the children as a group to contribute words or sentences regarding it until the description seems to us to have become an approximation of completeness. In the presence of a fire opal children suggested these terms: "Beautiful. Red, light orange, purple, blue, green, white. A glowing thing. Fire inside. You cannot see through it. Shines, flashes, gleams in the sun. Like fire blazing. The colors slide all around. A light is shining through. Some of it like soft clouds, some of it rainbow colors." Anyone familiar with the Japanese view of beauty in nature, as expressed in poetry, especially in the Hokku form, and in art, must be aware of the likeness between this and children's way of seeing and responding. It is moments in nature, and her tiny manifestations, which the Japanese love to capture; also they get and express a singleness of impression which makes not only for simplicity of form and composition, but for clarity and definiteness in thinking. The Japanese artist or poet can see a drop of dew shining like a miniature sun, a spiderweb with dewdrops on it making a design of strung jewels, a little fly with wings heavy from the rain crawling up a wet window pane, the shadow of a pine tree on a door mat, fireflies among the water weeds, concentric circles made by water spiders and "reeds that stand waiting when the wind is about to rise." The following Hokku poems give further illustration:

A stem of grass
Whereon in vain a dragon fly attempts to light.

O little butterfly,
With wings still moving even when it lights.

The rains of spring!
Hanging to the branches of the green willow
They look like pearls upon a string.

An early morning breeze,
A single goose up in white clouds, and nothing more.

The clouds on spring winds borne
Cast swiftly moving shadows on the waving fields of corn.

Children's awareness of natural beauty can be extended by the use of an adjustable tripod magnifier, especially in the case of stones, mosses, lichens, bark, grasses, seeds, snowflakes, and insects. It is better than a hand glass, except in the case of the insects and the transient snowflakes, because it invites to a longer and better focused scrutiny. Children soon learn that better vision makes any natural object more interesting and usually more beautiful; that by contrast, it is likely to make unnatural, artificial objects less so. A small instrument known as the symmetroscope, or artoscope, based on the prinicple of reflection like the kaleidoscope, can give to a child or anyone limitless esthetic recreation in the realms of design, color, texture and play of light. One thrilling experience can be produced with no other material than grains of gravel or sand; another with bits of bark, fungus, twigs, pine cone, and other woodsy fragments; another with rice, corn and other translucent grains; and so on, without end. The field of the symmetroscope can be rotated, producing a round of varied and beautiful designs. As in the case of the kaleidoscope, the slightest rearrangement of the objects produces a totally changed design series.

Children have shown much initiative and originality in selecting the natural objects which are to provide this entrancing pleasure.

Shadowgraphs with nature subjects bring out other aspects of beauty. Their function is to show grace of line, gradation of shade, proportion, flat form and flat design. These particular aspects children can appreciate the more keenly in shadowgraph, I believe, because of the elimination of color and other factors which are likely to dominate the attention when they are present. Arrangements of cat-tails and tall grasses, candle-branched teazle or mullein stalks in the fruit stage, and trailing sprays of large-leaved grapevine with their clusters of grapes, can all give effective results. This has not been carried on in a studied way, but spontaneously, letting children find their subject themselves and do with it whatever they please. Similar values are obtainable through the making of blue prints. In this field the subjects must be smaller but the available range of them seems to be greater. Fern fronds are good subjects; also tiny tree seedlings, winged and sailing seeds, feathers, seaweeds, and certain flowers. The whole of a spring beauty from blossom to root-tip, provides a rhythmically flowing form that can scarcely fail to make lasting impression if looked at with seeing eyes. Leaves are specially good because their shapes are so varied and so clearly defined. Sprays of evergreens, of the different kinds represented in one's neighborhood, insure good subjects as well as interesting research. Wheat and other grasses are satisfying also in the special type of beauty they can be counted upon to provide.

Getting acquainted with the grasses of one's neighborhood in all possible ways yields experiences of exquisite beauty in varied forms. Children of most suburban or country localities easily find, on a single walk, ten or a dozen different grasses; and the number discoverable throughout a season can be much higher. They discover panicles that are tufted, or feathery, or formed like a broom. Some droop fountain-like with gentle grace; and others seem to be bursting explosively from their protecting sheath. Some grass stems are pliant and bending or waving; others are stiff and stalwart. Some branching stems, fine as a hair line, have such delicacy that in certain lighting they are practically invisible and the spikelets on their tips seem poised, unattached, in space. Some of the common grasses are tiny; others taller than the children who find them. Coloration of grasses in flowering time and in seed time is a source of pleasure too. The tones reflect the seasons; the most delicate appearing in spring; the tawny or deepened ones in fall. Grass flowers, with their suppressed petals and lengthened stamens, have an interest and beauty especially their own. The gathering of grass bouquets is for anyone a worth while pastime.

Seeing natural beauty in detail is one way of sensing it. Another way is by awareness of vast stretches, as revealed in the heavens, in fields and meadows, in desert and dune lands, in sand coasts and the sea; and in long horizon lines of mountain ranges and hills. Chapter five has taken account of manifestations like these. Still another way is through recognition of sequences and successions and the pageants they produce. There is, for example, the pageantry of the heavens with their apparent processional marches of sun, moon, and constellations; of day and night; of the seasons, as they follow each other around. Also, there are separate pageants, within the seasons.

What could be more arrestingly beautiful pageantry than the envisioned life story of an annual flowering plant from

L. W. Brownell

WILD RYE. ONE OF THE MANY BEAUTIFUL GRASSES GROWING IN FIELDS, ON WAYSIDES AND ALMOST ANYWHERE

sprouting to ripened seed, with its manifold showing of forms and designs and its exquisiteness of color, texture and movement? Another seasonal pageant is the harvest one with its climactic display of the abundant glories of fall; grains, vegetables, fruits, leaves, nuts, as they ripen or mature in succession, each member of each order an outstanding creation of individual beauty. The migrating birds of spring and fall constitute another. The clouds, in changing effects of light make a pageant, too; and the imagination may find another in the changing form resemblances already referred to which clouds as they move seem sometimes to assume. The transformations of water, though not actually seen as a sequence, can offer a pageant to thought.

Appreciation of natural or essential beauty may help children to an appreciation of art; and the reverse may in some limited degree be true. But no one will say that the beauty and art are synonymous, for there is much in art that does not think of claiming to be beautiful. A work of art records some special interpretation, or impression, conceived in the mind of the artist. The beholder of this work of art, if he gets the intended message, is learning what another person thinks. It is true of course that his ability to get the message may mean that his own thinking was already attuned to receive it. But the point of this is, regarding little children, that it is better to let them find their standards of beauty in direct experience of nature rather than through the medium of interpretation or style. Why not go, in the most formative years of living, to the original rather than to its derivative; for it will be granted that art gets its inspiration and its copy largely from nature. Even the modern abstractions in drawing and painting, if they possess beauty, are likely to have their base in nature's fixed rules of proportion or rhythm.

Surely it is a mistake to think that a child, or anyone, must be exposed to "art" to keep his sense of beauty active. On a country walk one may come upon silvery, darting minnows in a brook, an ivy-grown cabin with its door-yard of late-flowering plants, a buzzard soaring, a frieze of processional grasses etched against the sky from the edge of an embankment, a horse in a meadow shying suddenly with curving rhythmic grace, a vine with berries on it trailing a gray stone wall, a sycamore tree with its pendent balls, standing in black silhouette against a flaming sunset. Or, if he should not happen upon these subjects, he could see countless others of equal value. When such possibilities are recalled, it is not difficult to realize the mood of the writer who said:

> I don't need your art exhibits
>   When the sunset does her best,
> Painting everlasting glory
>   On the mountains to the west.
> And your opera looks foolish
>   When the night-bird starts his tune,
> And the desert's silver mounted
>   By the touches of the moon.[8]

Art appreciation is surely one of the joys of this world; but it seems to have less significance for little children than it has for older people. The most modern elementary schools will agree, in the matter of art expression by children, that it is best to let them draw, paint, model, or construct what they see, as they see it, without grown-up intervention. There is a belief in letting children find their own technique. The school's part, according to this way of thinking, is to supply daily experiences from which may be born the impulse to do creative work; and also to supply attractive and varied materials as media, and the time and place for working. The subjects of art appreciation and expression are referred to again in the latter part of this chapter in a discussion of rhythm.

---

[8] Badger Clark.

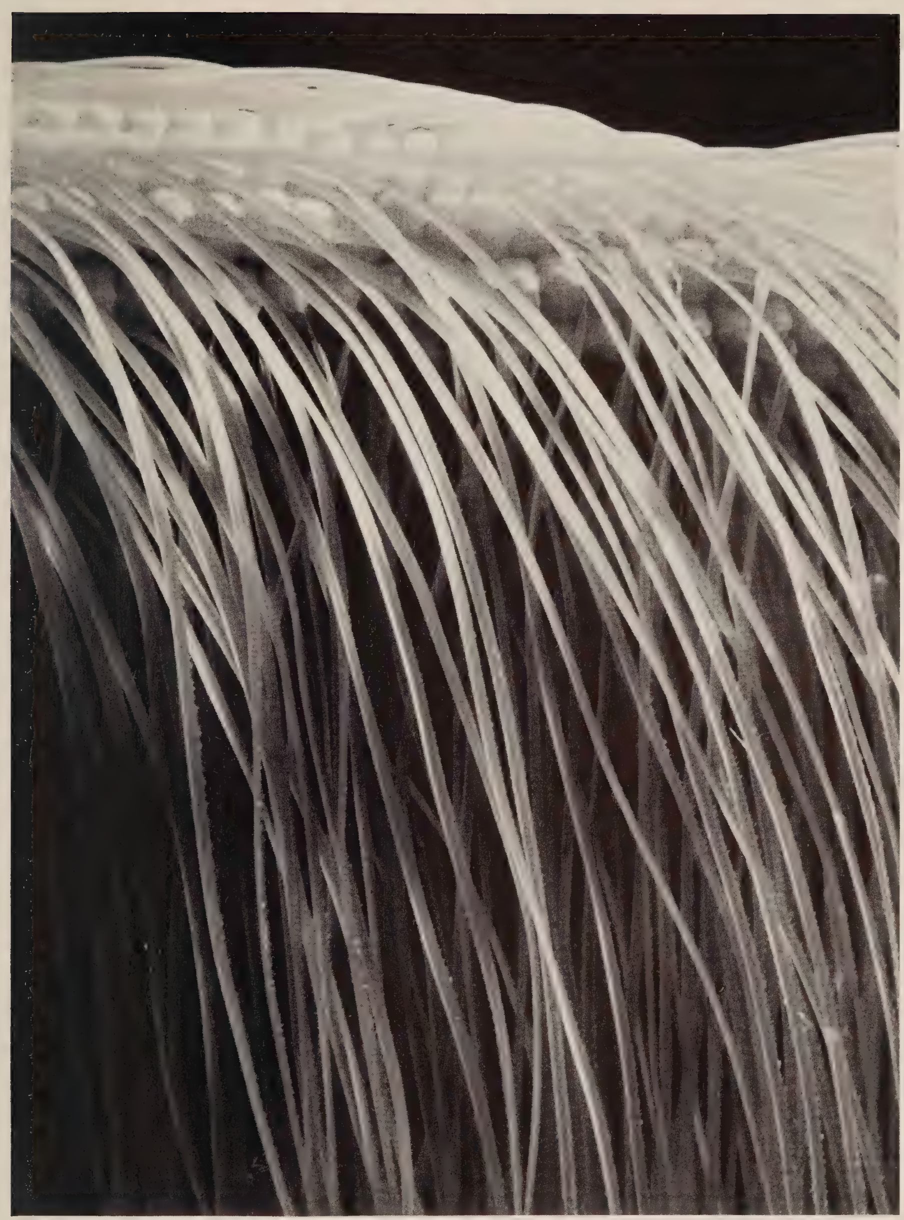
The *fact* of beauty, apart from its emotional aspect, has been analyzed in a chapter of Mr. Thomson's book, The System of Animate Nature.[9] He holds that certain qualities of form, color and movement in objects are objective. The lines and colors of birds and flowers, for example, are not "anyhow" lines and colors, but they have a positive character. What we see, Mr. Thomson says, sets up agreeable rhythmic messages; and the pleasedness is echoed throughout the functions of the body. This factor in the enjoyment of beauty is sensory or physiological. A second factor, according to him, is perceptual. The form of what we see is significant for us and satisfies our feeling; and beauty increases for us with significance of form. A third factor in esthetic pleasure, he says, is conceptual. It involves the idea that we seem to be unable to shut off the effect of concepts on percepts. An illustration is offered in "the concept of adaptiveness which is always in the background of the naturalist's mind."

Mr. Thomson brings out his meaning by making this quotation from Canon Hannay: "Above the rocks hovered the gulls with outstretched wings. Sometimes they slid down the wind till they almost touched the sea. Then with slow strong beatings of their wings they rose high again, slanted seaward against the breeze, swept in wide circles lazily indifferent as it seemed to destination, but bent on satisfying themselves with exquisite smooth motion"; and he says of it, "As we watch this every day sight we have purely esthetic admiration of the grace of the creatures and of the music of their movements. There is sensory pleasure and there is imaginative sympathy. But the delight is subtly heightened by an appreciation of the fitness of the birds to this mastery of the air—an appreciation that steals into the mind as an aroma rather than as a cold-blooded scientific reflection."

---

[9] Vol. I, Chap. VIII.

Mr. Thomson points out that certain forms are more pleasing than others; that, for example, an ellipse with its axes in the proportion 5-3 has been recorded as especially pleasing since 300 B.C. The approximate logarithmic spirals seen in horns, cones, shells and buds have a record of pleasing too. "There are lines that flow and shapes that sing. . . . Among organisms we like best those with flowing lines . . . and this is as true of the internal architecture of a sea-urchin's spine as of the external molding of a tiger." Color, Mr. Thomson says, emphasizes and enhances the value of form. "Keeping to those combinations and arrangements of lines and colors which are expressions of development, growth and activity, what strikes us as characteristic is their harmony. The expert in these matters is of course the artist, the producer of the beautiful and of more than beauty, and his verdict almost without exception is that every one of these wild creatures is an artistic unity. . . . Nature pronounces her verdict upon ugliness by eliminating it. Beauty is nature's stamp of approval on harmonious viable individuality, and just as, objectively, the ugly is only halfway to a thing, so it is subjectively. . . . We have unconscious or conscious standards of line, of color, of sound and movement. Just as a discord may break a precious glass vessel by setting up contrary



Aus Formen des Lebens von Dr. Paul Wolff. Erschienen in den Blauen Büchern des Verlages Langewiesche, Königstein i/Taunus

AN EAR OF CORN

vibrations, so there are color-schemes that almost literally jar, and muddy colors that are as painful as noises."

There seems to be a special tendency in modern times to establish or revive laws of beauty. In the field of color, processes which are accepted as laws by the color specialists bring them to certain tints, shades and combinations. With some of these specialists color study has a mathematical base; and they find scales and octaves in color which lead them to associate it with music. Color, it is generally accepted, is responsible for many emotional effects besides those to be classed as purely esthetic. Certain physicians and psychologists, as well as artists and decorators, are basing their procedure upon the findings of scientific research in this field. We are told that colors may be sedative, exciting, expansive, and so on.

But, as I see it, none of this information is needed or even employed legitimately in helping little children to become acquainted at first hand with the range of color experience which the natural universe provides; and surely none of it should be allowed to limit or qualify their natural desire for expression through color. The mathematical aspects of it are concerned more, it seems, with emotional effect than with understanding of nature. It is the legitimate province of children to be brought into the presence of all possible illustrations of nature's color, as shown by the birds, the butterflies and moths, the fishes, the shells, the flowers, the fruits, the fungi, the minerals, the skies, and so many other series, each one of them seemingly endless in the experience of beauty it offers through the factor of color. The reader is asked to halt and visualize these suggestions; merely to read them is not sufficient.

Brilliance of many birds, of flowers, of autumn vegetation, and of sunsets; iridescence of humming-bird and peacock feathers, of peacock ore and many other minerals, of soap bubbles and of glass like that of the Romans long buried in the earth; diffraction, as illustrated in the elusive coloring of opals and labradorite; illumination, as in the effect of sunlight upon silken white seed tufts, or the petals of a water-lily; the play of light, as on water or jewels; soft neutral tones of many shells, of certain velvet-textured butterflies and moths, and of fungi and other treasures from the woods; effective design wrought in color, as shown by the tiger, the snake, the moth, and the amaryllis; exquisite delicacy, as in wedge shells, grasses, and clouds—all these experiences of color and chiaroscuro, and so many more, are provided in universe study. Magnifiers, lighting and other devices can aid children to see more colors, and to see these colors better.

In the field of proportion and form mathematical laws of beauty have been sought in recent years by Jay Hambidge, Denman W. Ross, Claude Bragdon, Samuel Colman and others. They have searched nature for data which the artist could apply in his work. Theories of proportional form, dynamic symmetry, design based on magic squares and the like, have resulted recently and in the past from the analysis of natural forms with reference to such laws.

It is Mr. Hambidge's idea [10] that theoretically the creations of nature are mathematically perfect; that the intervention of time keeps things from the perfection intended for them. This time factor he has said gives a chance for all sorts of happenings. If things were made instantaneously there would be no interference and they would be perfect in quality and form. It is his view that our satisfaction in what we term a beautiful object in nature or art may rest upon that object's

[10] Expressed in a studio lecture, Feb., 1924.

demonstration of an ordered symmetry, universal in application. Static symmetry is the term he applies to the orderly arrangement of units of form about a center or plane. The outstanding characteristic is its fixedness; the snowflake he cites as the perfect example. Dynamic symmetry is the type found in a spiral shell, a whorl of leaves, or a pine cone. It is suggestive of life and movement.

The student of form in nature is almost overcome by the multiplicity of its manifestations. Mr. Thomson says, "Whether we gather shells on the beach or collect snow crystals; whether we study birds or brambles, hydroids or hawkweeds, we get the same impression of an overflowing form fountain."[11] Every probed field of natural science study yields its practically infinite number of forms. Of the animals, including the insects, we learn that in their tens of thousands of species they are beyond our comprehension. Leaves, though conforming to certain form classes, present a diversity that has apparently no end. The varied forms of snowflakes one writer refers to thus: "Bear in mind that, though a lifetime were spent in the search, no two of these spectacular beauties would ever be found exactly alike, none of them last more than a few seconds, none of them have been more than a fraction of a minute in their formation; they are engraved and etched and beaded and carved beyond the power of the microscope to investigate them."[12] The speculative numerical term which he applies to their varieties is "milliards of millions."

Scientists tell us that form in the organic world results from growth, and that growth is a combination of force and process. Bodies organic or inorganic, held together by the intermolecular force of cohesion, are pulled by the force of gravity and they are conformed by the physical force of friction or the chemical force which results in precipitation or crystallization. They are subject to the natural law that movement takes the line of least resistance; yet movement is even more decisively controlled by the original impulse which occasioned it. Other considerations in the production of form are intermolecular changing about and the formation of new cell units. "The slightest incipient diversities are continually reproduced and multiplied, like a slight error in the beginning of a long calculation, and thus very trivial differences between two seeds may generate an absolute unlikeness in the resulting plants." [13] In the animate creation a difference is presented in that life may take liberties with its physical environment.[14] That is, living bodies may influence their own form-making process as non-living bodies do not. Some concept of the mechanical explanation of form can reach children if presented by a procedure sufficiently simplified and providing adequate concrete illustration; the chemical explanation is probably wholly beyond them. When important omissions are deliberately made, the children's right understanding seems to demand that they be told that only part of the truth has been indicated; that the rest will follow when they are ready to receive it. An explanation of form should give a place to the idea which the term "original impulse" stands for. It is right, I believe, for children to know that life itself is something which science has not been able to run to cover.

---

[11] The System of Animate Nature. p. 11.

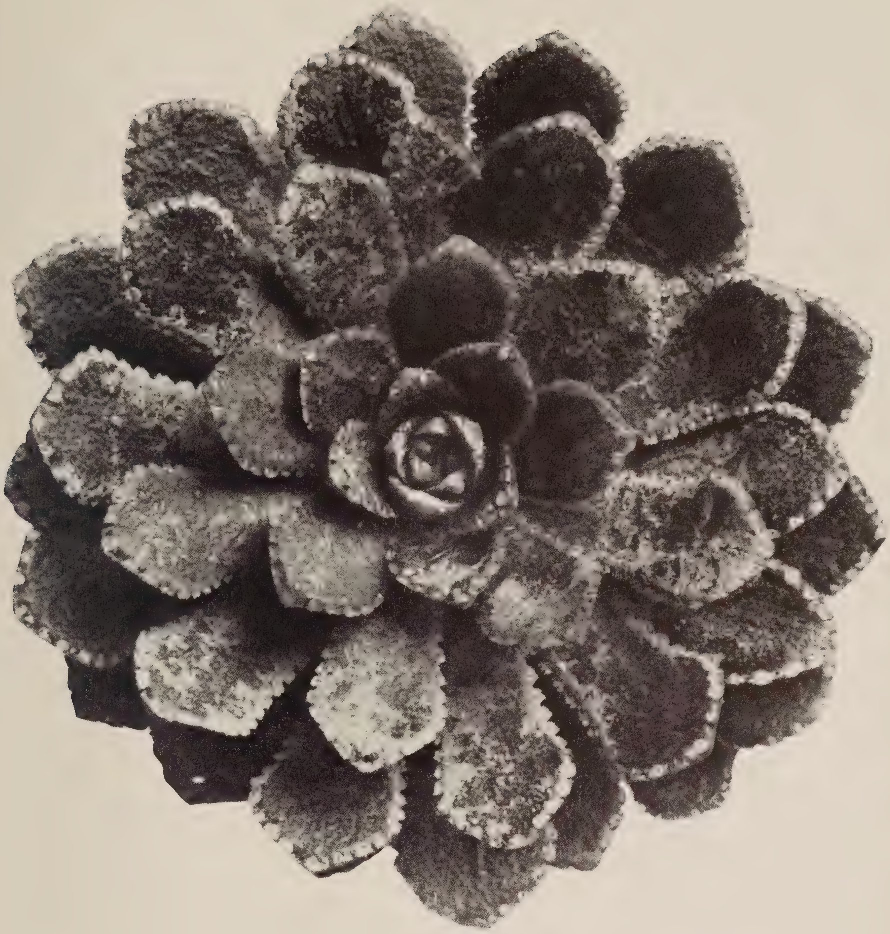
[12] Samuel Colman: Proportional Form.

In the appreciation of form in nature, children's spontaneous observations and explorations will carry them far; but

---

[13] James Hinton: Life in Nature. Smith, Elder & Co., 1862. p. 95.

[14] See John Burroughs: Accepting the Universe. p. 51.



Professor Karl Blossfeldt. In Urformen der Kunst.
Ernst Wasmuth A. G. Berlin

MARGINED PYRAMIDAL SAXIFRAGE. LEAF ROSETTE, ENLARGED

with the help of a little suggestion of the possibilities in some direction, their explorations and findings can go much further, sometimes bringing arresting illustration of natural order. Knowledge of the consistent ranking of leaves, or scales, provides for children one field of exploration. They are interested in learning, for example, that grasses are two-ranked; that is, by numbering the leaves in the order of their growth, they find that the third leaf stands directly over the first, the fourth over the second, etc. Sedges, as they may discover, are three-ranked; the scales of pine cones, thirteen-ranked. And this information they can add to at will.

The summation series of numbers 1-2-3-5-8-13-21-34-55-89 etc., in which each term after the second is composed of the sum of the two preceding terms, children may find employed in nature in various ways. In the first place the ranking just referred to is always in accordance with one of these numbers. The proportions represented by any two consecutive numbers in the series, as 3-5 or 34-55, are found recurrently in nature also. The sunflower head exhibits this.[15] The seed sockets form obvious series of intersecting curves which give to the head as a whole an appearance of movement and life. A small head will show exactly twenty-one long curves crossing thirty-four shorter ones; a larger head will show 34-55, and a smaller one 13-21. Pine cones looked at from the stem end display this proportional relation more obviously, and they afford a striking example of the dynamic symmetry described by Mr. Hambidge. The cones of the pitch pine provide perhaps the clearest illustration. Some of the common rosette plants show in their leaf arrangement the constant relation of 5-8.

---

[15] See A. H. Church: On the Relation of Phyllotaxis to Mechanical Laws. Williams and Norgate, 1901.

It is interesting also for children to know that some plants reproduce a specific number in several of their parts. The tiger lily reproduces six, the trillium three. Sheaves of pine, according to their species, dependably enfold two, three, five or seven leaves. Children can go fairly far with this kind of numerical discovery, once they have started in it; but I think its value might easily be overrated. It is worth while to be occupied with it in so far as it serves to get into their consciousness the idea that form in nature, in repeated instances, has a mathematical base. There is possible value too in that the symmetry of the forms they are observing is likely to give them a degree of esthetic or rhythmic satisfaction. To a certain point, I believe, this numerical interest makes for rational wonder and increased appreciation. Pursued beyond that point it is likely to let a purely mechanical noticing supersede these values. One would not want a child to miss responding vitally to the movement of a pine cone because he was busily counting its scales.

The geometric figures or forms of circle, sphere, ellipse, ellipsoid, curve, triangle, pyramid, cone, cube, pentagon and hexagon are, most of them, met commonly in the nature world. When children have become aware of these recurring manifestations it may be interesting to them to construct some of them with protractor and compass, using color if they wish, to heighten the interest of the designs that may result. The kaleidoscope is a further aid to experience in this field. It has been suggested in this regard that geometric imagination can be cultivated if a light is placed in the bottom of a deep, round jar in a darkened room, and a sheet of cardboard is held over it.[16] The light throws on the cardboard patterns of conic sections which pass into each other as the position of the cardboard is changed. Also, a simple experiment is recommended with the shadows of round and elliptical rings.[17] In this, a sheet of white paper is placed on a table. If the round ring is held between the paper and an overhead light, it casts in succession shadows of a circle, an oval, or straight line according to the position in which it is held. The same series of shadows is produced when the elliptical ring is used; but a knitting needle, or other straight line object, the children may discover, cannot produce the circle or oval.

---

[16] Mary Everest Boole: Preparation of the Child for Science. p. 71.

In another connection it is suggested that children may draw circles with a pencil constrained by a loop of thread fastened to a fixed pin; also, having two pins placed at a little distance from each other within the loop; and again, three pins.[18] Anyone doing this can see the thread make trigons, tetragons, pentagons, hexagons, according to the number of pins. And these forms change from one to another until the circuit has been completed.

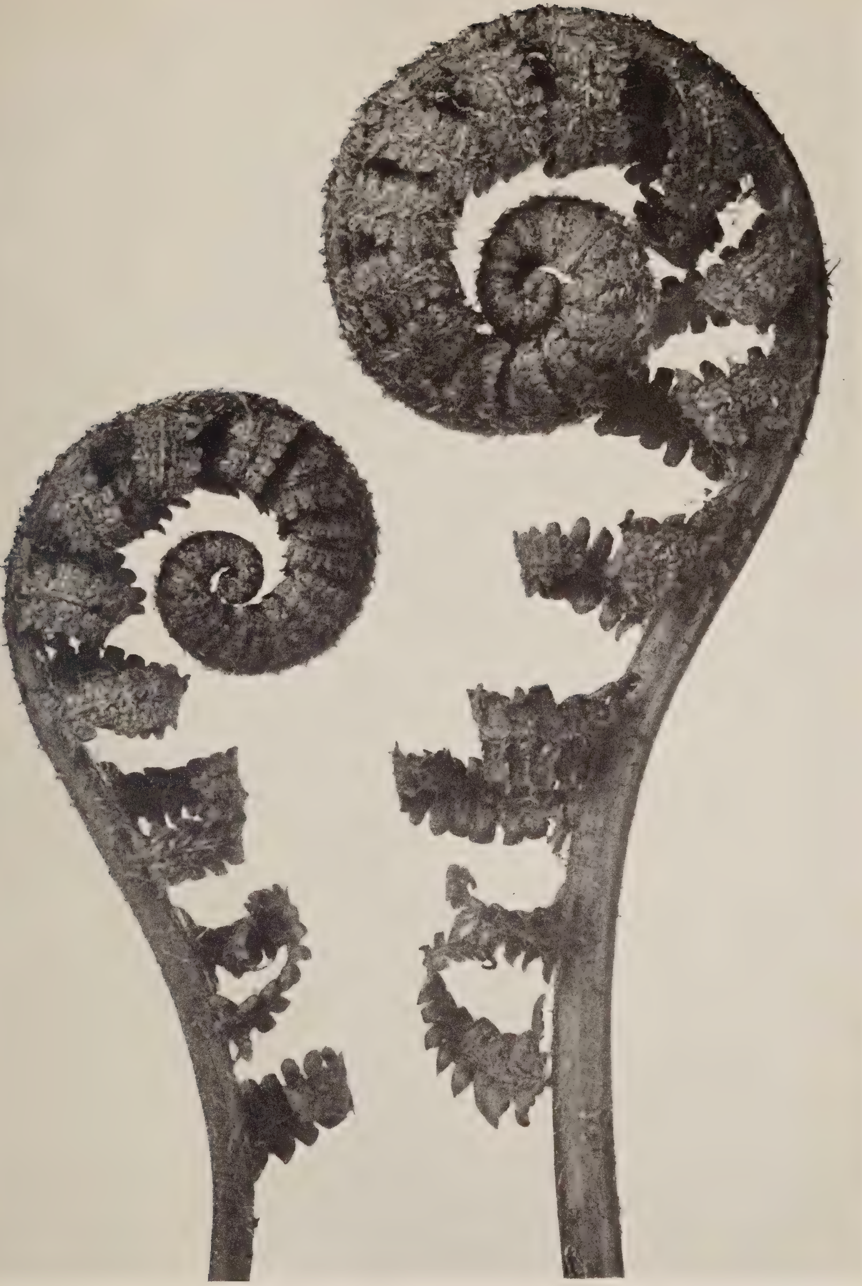
Rounded shapes in nature are everywhere at hand. Spherical form is illustrated for children in increasing dimensions all the way from tiny, round seeds to suns. Nature's spherical pattern has been accepted for perhaps the most cosmopolitan of children's playthings, the ball. Approximate elliptical form is illustrated by certain leaves; ovoid form appears in eggs, certain seeds and nuts, and many flowers in bud. Based upon the circle are radials and rosettes, forms of beauty which may be among the loveliest we know. The dandelion plant in anybody's back-yard illustrates both of these and also the sphere: the rosette is made by the green leaves lying flat on the ground; radial form appears in the yellow florets, suggesting irresistibly to children the rays of a little sun; the sphere is the white fairy-land globe made of tufted tiny fruits, on their radial stalks.

---

[17] Same. p. 111.
[18] Same. p. 112.

Flowers are our most obvious, varied and perhaps our most beautiful radials. But radial form is yielded amply also in the animal life of the sea. The starfish of five or more rays, the many-spined sea-urchin, the tentacled sea anemone and jelly-fish, are examples of this. The ridges and markings on certain shells are radial also. Illustration of this form, when it seems to shoot forth dynamically, is found in some pine needle and palm and cactus leaf clusters; in flat arrangement it appears in the verticils of certain plants—a term for a circle of leaves, flowers or other organs about the same point on the axis. Snow crystals are radial; so also are some crystal aggregates, such as those of wavellite and tourmaline. This form is exhibited in the framework of a spider's web and in the spread feathers of a peacock's tail. The microscope reveals radial forms of almost unbelievable variety and beauty; but these are among the discoveries reserved for the education of later years.

Rosettes are a kind of radial. The rosettes of certain weeds are experiences of beauty which almost any field or country roadside may offer. The best time to look for them is in the fall or the winter. The rosette of the dandelion has already been referred to. Other plants whose leaves yield beautiful forms of this kind well worth the attention of children or anyone are the mullein, the thistle, the plantain, the hawkweek, the tansy, the sorrel, the primrose, the goldenrod and the aster. Rosette beauty is brought out and for a time preserved if the more perfect examples are paraffined, with a heated iron, on paper that is of a suitable color for back-



Professor Karl Blossfeldt. In Urformen der Kunst,
Ernst Wasmuth A. G. Berlin

SHIELD FERN. YOUNG SPIRAL FRONDS, ENLARGED

ground. If the paraffin covers paper as well as leaves, an attractive parchment-like effect is obtained.

The circle repeated in concentric design is found in nature also, affording not only interesting form, but in many cases a record of growth. Common examples of concentric circles within the possible experience of most children are the transitory ones made when a stone is thrown into a body of water; the ridges or lines which appear on certain shells; the circular areas revealed in the transverse section of a tree, a stem, or an onion; the layers which some specimens of agate show. Allied to the circle is the curve, which we have always heard is preëminently the line of beauty. Children can anticipate this generalization in their discovery and enjoyment of certain curves which have a recognized place in nature, mathematics and art. Catenary curves, which are those formed by holding apart the two ends of a slack rope or chain, find beautiful illustration in the web of the field spider, in the veining of certain leaves, and in the dipping flight of birds. We see applications of it in the festooning of garlands, or in jewel-strung necklaces. Of the form in general it has been said, "No one who has for a moment glanced at a chain caught at both ends and swinging its loose bite in the sunshine ever failed to note the graceful curves formed in every motion. These catenary curves are among the freest examples of the influence of gravity." Other illustrations of pleasure-giving curvature in nature are found in the rainbow, in the roots and branches of trees, in the droop of the panicles of grasses.

The most arresting and recurrent of nature's curves is the spiral. A scientist says of it, "One general fact may be referred to—the universally spiral form of organic bodies. The most superficial glance reveals a spiral tendency as a general characteristic both of the vegetable and animal creation; but a minute examination traces it in every detail. An essentially spiral construction is manifested from the lowest rudiments of life, upwards throughout every organ of the highest and most complex animal. The beautifully spiral forms of the branches of many trees, and of the shells which adorn the coast, are striking examples merely of an universal law. But the spiral is the direction which a body under resistance ever tends to take."[19] One writer[20] in his books, Spirals in Nature and Art, and Curves of Life, has revealed a thorough study of this subject and presented hundreds of graphic illustrations of nature's spiral forms. Thus it is not surprising that children should find in the world about them many an example of spiral form or movement and that their attention should be gripped thereby.

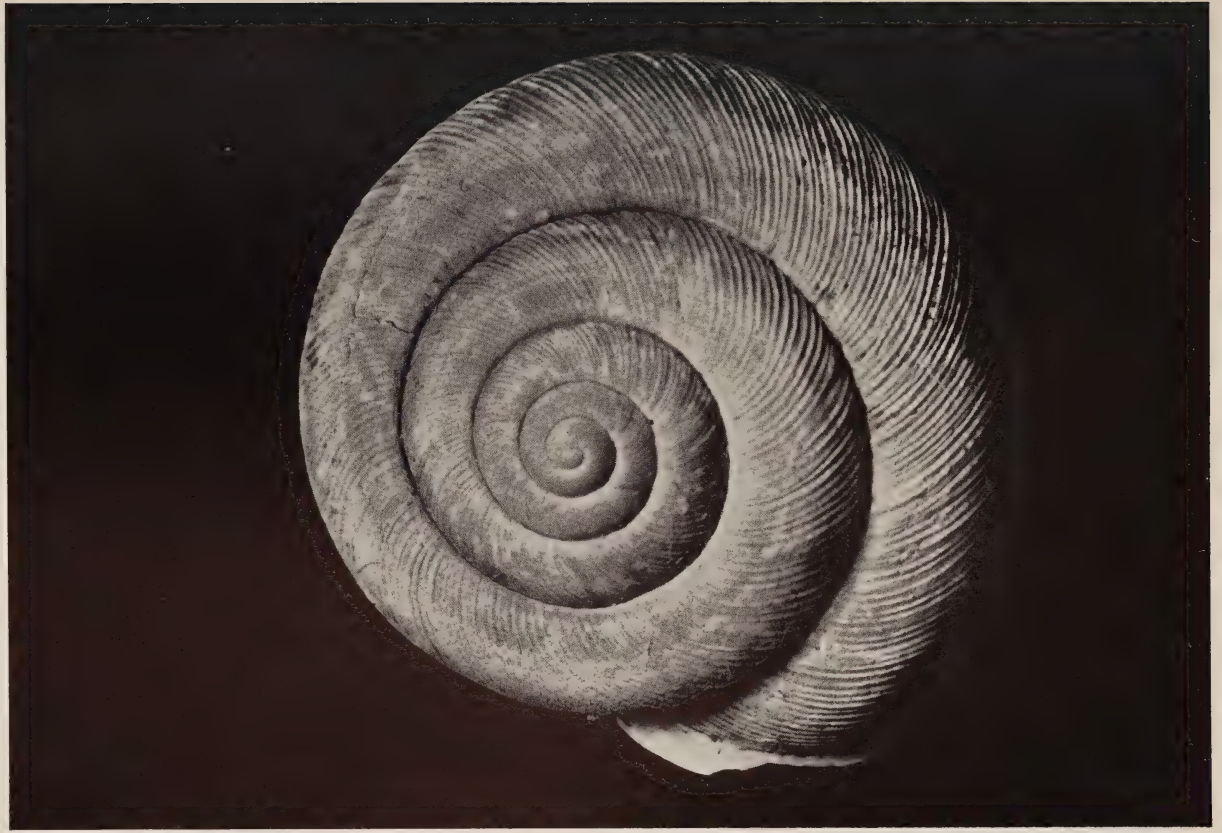
The characteristic spiral of nature is not that of the watch spring in which the areas between spiral lines are of equal breadth, but it is the approximate logarithmic spiral in which the spires tend to increase in breadth in numerical series.[21] The best illustration of the spiral is perhaps the nautilus; the most common, the snail shell. Flat spirals, all in one plane, may occur; but generally, as spirals unwind, the elevation changes. Eccentric spirals, which seem as they wind away from the starting point to follow no consistent scheme, may be seen in sea-worm shells and in animals' horns. Spiral arms proceeding from a common center are found in nature as illustrated by some of the spiral nebulæ and the flowering of the cyperus plant. Climbing vegetation twisted around a stem forms a helix rather than a spiral; for in this case there

---

[19] James Hinton: Life in Nature. p. 574. In Humboldt Library of Science. J. Fitzgerald.

[20] Theodore Andrea Cook. John Murray, 1903. Henry Holt & Co., 1914.

[21] Samuel Colman: Proportional Form. pp. 46 ff.



Cornelia Clarke

THE COMMON SNAIL SHELL IS AN APPROXIMATE LOGARITHMIC SPIRAL. ENLARGED

is no essential alteration of distance between the winding plant and its movement center. The most beautiful illustration of the spiral is perhaps the spiral nebula, familiar as a photographed object to children who have studied the heavens. Dr. James E. Keeler of the Lick Observatory stated in 1900 that the number of nebulæ within reach of the Crossley reflector was then 120,000 and that nearly all of these have a spiral structure.[22]

Among the spirals which children are likely to discover for themselves are those found in snail and other shells, in the budding fern frond, in tendrils, in the tip of asparagus stalks, in the horns and plumes of animals, in curling hair, and in a spider's web. The sweet pea provides variations of the spiral in both its twisted seed pod and its tendril. Many flowers looked at closely reveal the spiral arrangement of their parts. This is obviously and beautifully true of the wild white water lily. Watching a flower's opening from the bud may promote this observation, especially in the case of the chrysanthemum, the double dahlia and the garden rose. The leaves on a stem can also illustrate spiral arrangement. A line drawn through the successive leaf bases might trace on the stem a helical curve; but if the leaves be looked at from above, the pattern of them taken together is clearly a spiral. This is equally true of a leaf rosette. It is an arrangement which results, science tells us, in the utmost possible exposure of the leaves to sunlight. Spirals may be suggested by winged seeds of maple or sycamore, by twisted seed pods and tree trunks, by cordate leaves and shells.

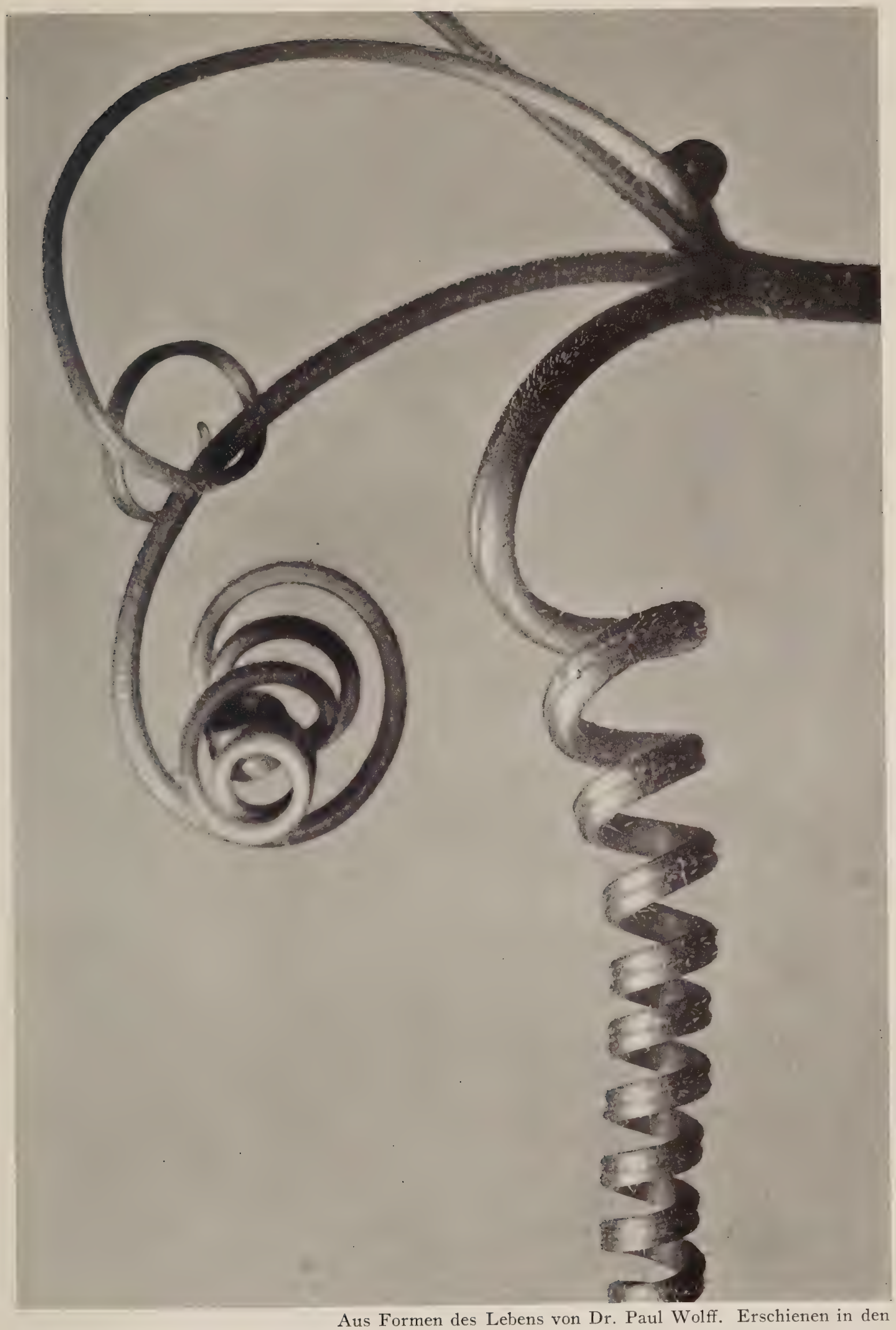
Children, for generations surely, have been attracted by the spiral form of shavings from a carpenter's bench, of the dandelion curls which they make, of soap bubble films impinging upon other films previously formed. They notice too such transitory spirals as those seen in the coils of a snake, an elephant's trunk or a monkey's tail; in water going into the drain of a basin; in wind-caused movements such as dust whirls and whirling leaves. A spiral phenomenon of a still different class may be observed in the flight of birds. These last illustrations have to do with spiral movement rather than fixed form; they are referred to later in the discussion of rhythm.

---

[22] In an article in The Astrophysical Journal, June 1900.

Forms in nature made of straight lines are for the most part based on circles; circumscribed, they may produce them. The triangle is, in nature, not a common form. Certain seed pods, parts of certain flowers, and cross sections of certain stems afford perhaps the most available illustrations. Mr. Colman, in a drawing, makes a butterfly belong to the triangular class by producing the side lines of the wings until they meet in a point. Frost forms some times approximate it. The pyramid form, with varying numbers of faces, is found in crystals, most easily observed perhaps in the ends of quartz crystals. The cone of course finds outstanding illustration in pine cones; but it appears in shells and in buds and other parts of plants. The volcanic cone, though differently produced, is an example of natural cone that is not likely to be overlooked.

Cubic form finds its best illustration in crystals, and especially in crystals of salt, galena, fluorite and pyrite. The pentagon occurs in nature but it is more often indicated than definitely delineated. The rhomboidal protuberances on pineapples provide perhaps the most familiar example. But this form can be produced by drawing connected lines on five-petaled, five-lobed, five-leaved or five-rayed objects of nature, such as a wild rose, a morning-glory, a laurel or



Aus Formen des Lebens von Dr. Paul Wolff. Erschienen in den Blauen Büchern des Verlages Langewiesche, Königstein i/Taunus

SPIRALLING TENDRILS OF A SQUASH PLANT

pumpkin blossom, a woodbine leaf, and a starfish. In the case of petals, sepals, lobes or leaves the lines are drawn connecting either their tips or central points in their outer edge. In the case of a rayed object, the lines connect points on the rays that are equidistant from the center of the object.

The hexagon, as such, appears more commonly. Mr. Colman says, "Perhaps in all created things no more beautiful example of the workings of the law of polar force, or more perfect hexagonal design can be found than in one of the whirling snowflakes formed and re-formed while making its one terrestrial journey from the dull gray wintry cloud that conceived it, through a few short seconds to the drift where it joins its storm-born mates." [23] Of this form he says further, "Why should water freezing freely in the air so demonstrate geometry by forming, as it does, a star with six rays, each set to another, at an angle of sixty degrees? And as if to prove geometry divine beyond cavil, sometimes the rays are only three in number—a factor of six—and include angles of twice sixty degrees. Moreover, the rays are decorated, making thousands of intricate and beautiful forms; but if one ray of the six is ornamented with additional crystals the other five are decorated likewise." [24] Children have sometimes in their drawing tried to invent possible snowflake forms, keeping carefully to the basic principle of six. The transiency of snowflake beauty creates some difficulty in children's initial observational experience. But as soon as they really know what to look for, they see the forms with ease.

Another wonderful example of hexagonal form commonly observed is the comb of the honey bee. Of this we read in The Garden of Cyrus, "Every cell affords a common side unto six more, and also a fit receptacle for the Bee itself." [25] There are but three figures which of themselves can fill the space around a point.[26] These are the triangle, the square and the hexagon. The hexagon, we are told, is the best contrivance for a honey cell because since it has most angles it can contain the most honey. Another example of natural, regular hexagons is found in certain corallites. Also, by the line drawing process described in reference to pentagons, many illustrations of hexagons can be produced from parts of plants. This is true, for example, of six-petaled and six-sepaled flowers like the lily and the jonquil.

---

[23] Proportional Form.
[24] Proportional Form.

In the field of physical experiment there are certain simple procedures which, if followed, will yield this form. In soap froth imprisoned between two plates, regular hexagons may be seen. Also, if a triangular dish of mercury is set vibrating by tapping it on the sides or by the aid of a tuning fork, the resultant will be "a series of little waves or ripples starting towards each other from each of the three faces; and the intercrossing, or interference, of these waves or ripples starting inward from each of the three faces produces crests and billows and intermediate points of no disturbance whose loci are seen as a beautiful pattern of minute hexagons." [27]

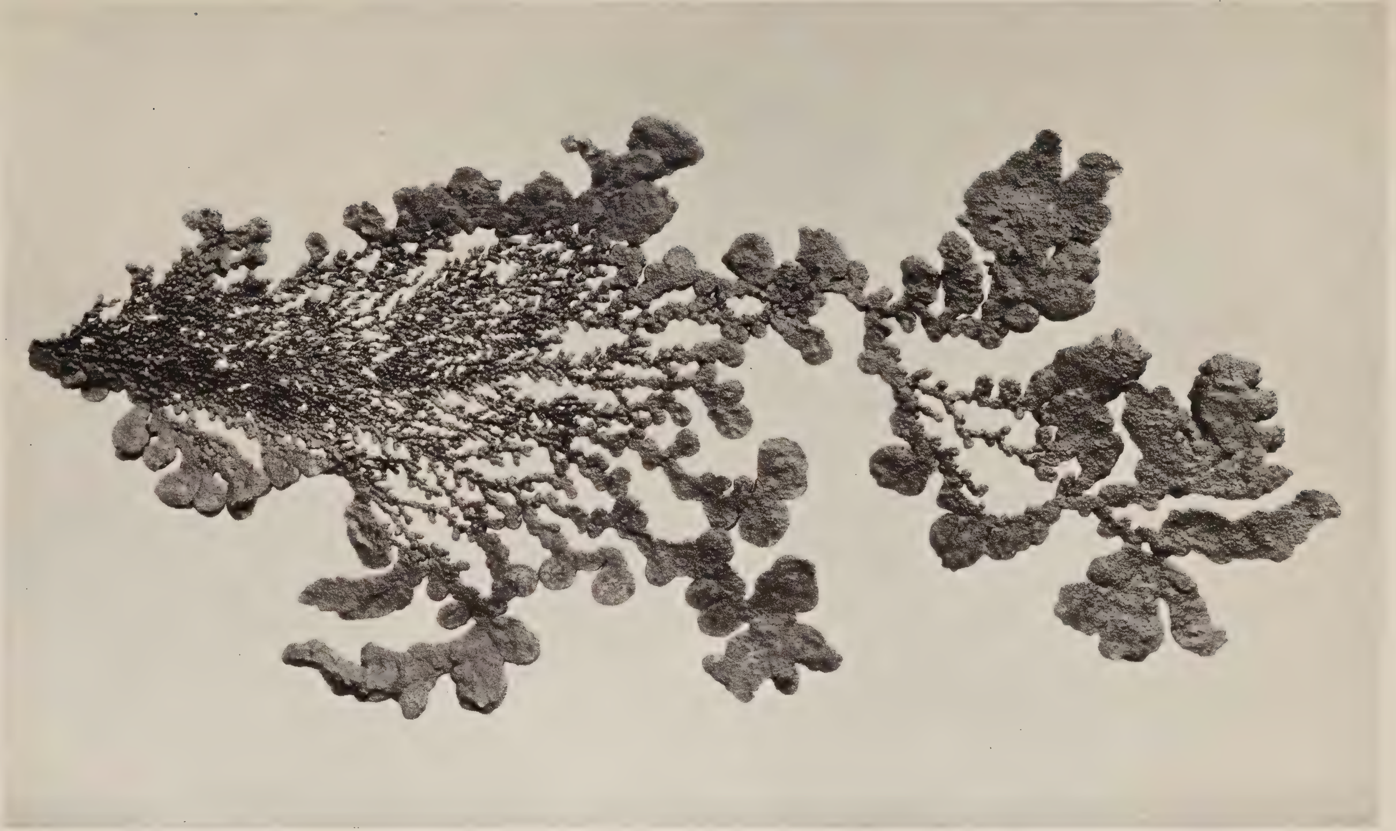
In nature is found also, in addition to the geometric figures and forms just referred to, a form like the branching of trees, called arborescent or dendritic. This form is found not only in vegetation, but in certain corals, in the horns of deer, in the patterns of window frost, and in certain minerals, including moss agate and gold, silver and copper crystals. Some mineral crystals so much resemble coral, as for instance a

---

[25] Sir Thomas Browne. The Macmillan Co., 1911.

[26] See D. W. Thompson: On Growth and Form. Cambridge University Press, 1917. p. 329.

[27] D. W. Thompson: On Growth and Form. p. 322.



Smithsonian Institution, U. S. National Museum

COPPER IN DENDRITIC FORM. CRYSTALS OF GOLD AND SILVER
APPEAR IN THIS FORM ALSO

branching form of aragonite, that the term "coralloidal" has been adopted to describe them.

This discussion of form in nature, like that of numerical principles in nature, has the specific purpose of promoting appreciation. The information included is not offered as teaching material, but as a reminder to the teacher or other adult associated with children of some things true in the matter of form which may guide him in creating or arranging an environment that is significant with regard to beauty and is thought provoking. If any of the information included here is pointed out to children this should be done because the children's own explorations and discoveries have brought them right to the place where information can serve to send them farther along on their independent researches. Here as always the teacher or other adult must have some realization of the possibilities; also an interest so genuine and so keen that he and the children will be mutually responsive.

Beauty finds close association with rhythm, as pointed out in statements quoted from Mr. Thomson. He has called to our thought "the Shetland ponies racing in the field, the kingfisher darting up the stream like an arrow made of a piece of rainbow, the mayflies rising in a living cloud from a quiet stretch of the river,"[28] and has said that these external rhythms may be echoed in our own internal rhythms. The interpretation of this may be, perhaps, that there is definite connection between one's enjoyment of visual beauty and his consciousness of rhythm. On this basis it is probable that if an individual's consciousness of rhythm be developed through training, his response to rhythm wherever he sees it will be increased and his appreciations enhanced.

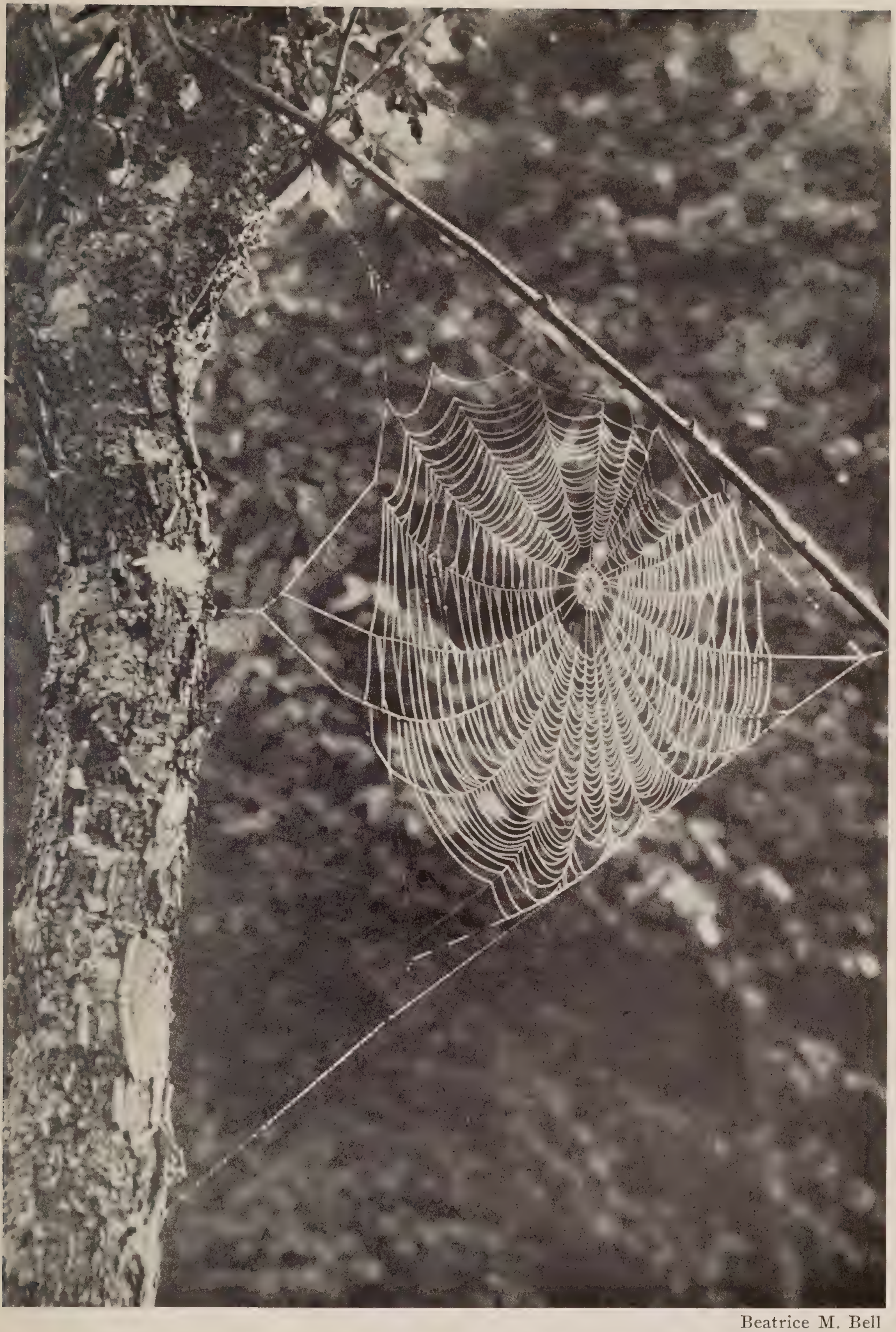
Children's spontaneous response to suggested words, by the method referred to earlier in this chapter, is very likely to bring evidence of their tendency to store away impressions of movement. If they have had rhythm training this tendency is naturally greater. There is evidence of it also in the following examples of children's more deliberate written expressions which, in each of these selected cases, were produced without any suggestion to them of subject or idea: "When something is moving and the sun shines on it, it looks as if the sunlight is dancing." "The wind blows the branches and they seem to dance. It blows the leaves and they seem to run and jump." "The clouds move in such beautiful order, in lovely soft movement and changeable shapes. And the clouds move across the moon and seem to weave in and out of the moon but they are just passing by." "The sun shines on the dust, and the wind makes the tiny dust flakes move. They are not just in one place. They are all over in the sun's light. They are like lights that go on and go off. They move slowly and softly, up and down and all ways." Other expressions have been written as verse. The title of the first of the examples which follow is Fire; of the second, Beautiful Things.

---

[28] The System of Animate Nature. vol. I. p. 267.

A flickering and a flash
A flickering and a flash
A great blazing blast of heat
And everything turned to ash.

Sometimes I see the flowers swaying,
I see the corn rocking back and forth.
Sometimes I see the fire moving gently.
On the lakes, reeds sway.
On the lakes sometimes when it rains, part of the lake is sprinkled and the rest is clear.
It is beautiful to see.



Beatrice M. Bell

RADIAL, SPIRAL AND CATENARY CURVES HELP TO MAKE THE BEAUTY OF THE ORB WEB OF THE SPIDER

The universe we are part of, in so far as our knowledge penetrates it, is essentially rhythmic in its movements. If we do not perceive rhythm in the universe we do not perceive the universe at all. In speaking of dancing, which is rhythm finding form, Havelock Ellis says, "The significance of dancing in the wide sense thus lies in the fact that it is simply an intimate concrete appeal of a general rhythm, that general rhythm which marks, not life only, but the universe, if one may still be allowed so to name the sum of the cosmic influences that reach us. We need not, indeed, go so far as the planets or the stars and outline their ethereal dances. We have but to stand on the seashore and watch the waves that beat at our feet." [29]

John Fiske has said, "The longer astronomic rhythm, known as the earth's revolution, causes corresponding rhythms in vegetable and animal life: witness the blossoming and leafing of plants in the spring, the revival of insect activity at the same season, the periodic flight of migratory birds, the hibernating sleep of many vertebrates, and the thickened coats or the altered habits of others that do not hibernate." [30] Mr. Whitehead says that life preserves its expression of rhythm and its sensitiveness to rhythm; he calls attention to the fact that "living bodies exhibit rhythm of the greatest subtlety within our comprehension. Solar systems and star clusters exhibit rhythm of a simplicity analogous to that of molecules"; [31] but he points out that apparent complexity on the one hand and simplicity on the other may merely indicate our own angle of vision.

Physical science in the last analysis reduces the material universe to vibration. "Every physical process," we are told, "is, necessarily, the adding of force in one direction, the withdrawing of it in the opposite. . . . Nature vibrates with perpetual plus and minus; it vibrates and no more . . . be it wrought out in whatsoever forms, spread over whatsoever time." [32] The ordered vibration of nature is what we know as its rhythm. Symmetry of form in the nature world is a record of rhythmic growth. Movement is perpetual. All things are in a state of flux. Looking at the universe from a high mental tower, John Burroughs wrote of it in his later years, "Rocks decaying to build more rocks, nations disintegrating to build more nations, organisms perishing to feed more organisms, sea and land interchanging, tropic and arctic meeting and mingling, day and night, winter and summer, chasing each other over the earth—what a spectacle of change, what a drama never completed." [33] Of this endless flow and change and its rhythmic aspect Walt Whitman says, "The universe is a procession, with measured and beautiful motion." And another poet adds:

---

[29] The Dance of Life. pp. 36, 37.

[30] Cosmic Philosophy.

[31] The Principles of Natural Knowledge. Cambridge University Press, 1919. p. 195.

Trees in their blowing
Tides in their flowing
Stars in their circling
Tremble with song.

When we are considering the rhythm of the universe we realize that some of the natural movements known to us, like those of the heavenly bodies, or of mountains and rocks in their making and unmaking, we see not at all, or too slightly to have meaning, as visualized rhythm. They involve factors of space or time beyond the scope of our physical senses. There are other movements which occur too quickly or too slowly for us to see them well; but slow motion and accelerated motion pictures, previously referred to, are in these days helping to increase our knowledge and experience of movements of this class. They are giving us beautiful revelations, for example, of waves; of phases in the growth of plants, including a flower's life sequence; of the movements of animals, and of dancers and athletes. Outside these two classes lie the more evident manifestations of rhythm so numerous they can crowd experience, especially in the case of those persons who live in the country and are interested to observe them.

---

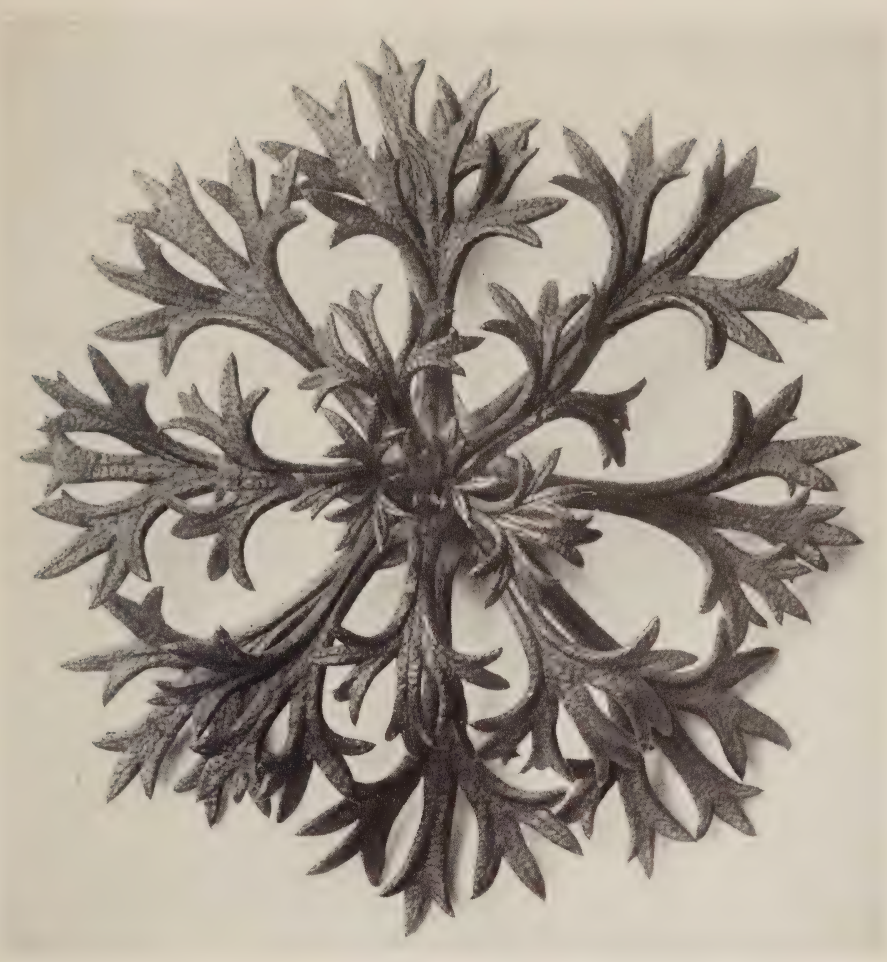
[32] James Hinton: Life in Nature. pp. 194, 195.
[33] Accepting the Universe. p. 107.

The movements of animals and birds afford to children an interesting field for study. Domestic animals yield the observer a varied experience; so also do the common birds, not only in their flying but in their modes of walking or hopping. Trips to a zoo are an important supplement to ordinary experience, and the rewards may be amplified and to some extent preserved if children take with them their snapshot cameras. It seems to be true that the animals we term wild exhibit illustration of rhythm more unfailingly than the domesticated varieties do. A little girl, watching a swinging gibbon, made the comment that his arms were like rope. Observing a kangaroo's jump, she noticed that he did not end it suddenly when he touched the ground, but finished or balanced the movement by coming up rhythmically. The bear had a "waving" walk.

Another zoo experience may be an otter, diving diagonally downward, his body sinuous as a snake's. Yet, for all its sinuousness, he seems to leap into the water in a direction as straight as an arrow's. In the water, movement seems to ripple through him; and he varies his progress forward with beautiful sidewise twists, his head turning first, and his body continuing the movement. The glorious peacock struts about with dancing walk and back step, his own spread tail providing the background against which one may see him. The elephants sway gently forth and back in a scarcely perceptible movement of perfectly balanced, rhythmic, alternation of weight. The zebras, running about in their stripes, suggest to one the dizzying possibilities of zebra group work which some animal trainer may some day discover and bring to an astonished public. Reference to the rhythm of bird flight is made later in this chapter; also in chapter six.

Rhythmic movements appear recurrently in children's play, in their singing games, and in such sports as swimming, fencing, golf, rowing, archery, baseball and many others. The world of occupations provides them too; the farmer sowing, reaping and tossing hay; the sailor hauling rope and the cowboy throwing it; the fisherman casting his line; the conductor leading his orchestra and the violinist stretching his bow. All these rhythmic occupations and many more are or have been commonly seen illustrations. And it is interesting to note that the machines now taking the place of some of these human operations have in certain instances lost us nothing in demonstration of rhythm. The automaton recently perfected to illustrate and teach correct strokes in golf is an outstanding example of this.

Rhythm is a term derived from the Greek *ῥυθμός*, meaning measured motion, proportion; but the root of this word is the same as that of the verb *ῥέω*, which means flow. The term rhythm is used here with the connotation of this root meaning. Flow in movement signifies sequence; rhythmic sequences include the factors of balance and recurrence. A familiar but limited definition of rhythm is "movement char-



Professor Karl Blossfeldt. In Urformen der Kunst.
Ernst Wasmuth A. G. Berlin

WILLKOMM'S SAXIFRAGE. LEAF ROSETTE, ENLARGED

acterized by alternation of stress and relaxation."[34] The concept of rhythm should be in reality distinct from that of the beat of time because of the flow and the balance, but it is often erroneously accepted as identical with it. The ballet dancer always expresses time; but usually he has not the rhythm which should underlie the time. In the arts, the meaning assigned to rhythm is "due correlation and interdependence of parts producing an harmonious whole."[35]

Analysis of the flowing, rhythmic movements of nature easily reveals a few typical movements which can serve as a base of classification for all. Conspicuous among these are the following:

(1) Circling rhythm, which includes spiraling, revolving, winding, soaring. Among its illustrations are the spiral nebulæ and the orbit-bound planets, moons and comets; the winds and certain wind-caused movements such as dust whirls and the less commonly experienced sand spouts, water spouts, cyclones and whirlwinds; the ocean currents, whirl-pools, and curling waves; certain phases of plant growth, and certain phases of bird and insect flight. The spiral, which is the movement principle of all evolutionary growth, can be illustrated by the arms which a nebula hurls into space or by the minutest processes of growth in a plant. It is really the one great essential rhythm of physical process; and similarly it is the strongest, most coördinating experience the student of rhythm knows. It may seem, to his consciousness, to be a figure of universal harmony in which he himself is included.

(2) Undulating rhythm, seen statically as a record of movement in the sky-line of mountain ranges, in foot-hills, in rolling meadows, in the meandering course of a river, in

---

[34] Century Dictionary.
[35] Mowbray's English Dictionary.

ripple marks or wind lines left on sand, in the form of a tree and smaller plants in their wholeness. This rhythm is illustrated actively by moving dunes; by rippling waves; by the movement of snakes; by squirrels in their running, leaping and darting, and by tigers and other cats. John Burroughs wrote of it, "A fox goes loping along with inimitable grace and ease. His large and massive tail, so far from appearing a burden, seems to contribute to the lightness and buoyancy. It softens the outlines of his movements, and repeats or continues to the eye the poise of his carriage." [36]

(3) Movement in two successive phases, upward and outward. This is illustrated by the growth of a tree, and by the wind-caused movements of smoke, flame, steam; and it is suggested sometimes in the tossing of spray and the scattering of seeds.

(4) Movement upward and over, as in the fountain-like action of an oil gusher, a geyser, or an artesian well. There is a record of such movement in the drooping form of certain grasses, flowers and trees.

(5) Movement forth and back. This is the swinging rhythm of the waving bough, of grain, of marine plants and the sea floor, and other pendent or otherwise attached objects which wind or water or other force finds sufficiently unresistant. Its greatest illustration in nature is found in the ebb and flow of the tides. Associated in consciousness with it are what have been termed passing rhythms, although these may be actually but parts of some one greater rhythm. The star drifts referred to later in this chapter afford an apparent example; another is supplied to a person who watches the sun disappear below the horizon simultaneously with the moon's appearance above the horizon in the opposite part of the sky.

---

[36] Squirrels and Other Fur Bearers.

When these movements are performed quickly we think of them as bursting, shooting forth, cracking off, hurling, leaping, darting, bounding, whirling. When they evolve more slowly to our consciousness we term them stretching, spreading, unfolding, floating, sailing, wafting, soaring, flowing, and, in the case of clouds, evanescent. The beauty and the definiteness of all these rhythmic movements demonstrate why it is that children's ideas concerning the universe find natural, easy and satisfying expression through the medium of rhythmic dramatization. And rhythm training may be regarded as fundamental in so far as it really helps children to express, through movement, their inner feeling of these universal rhythms. It is not fundamental if it merely helps children to present some appearance of them.

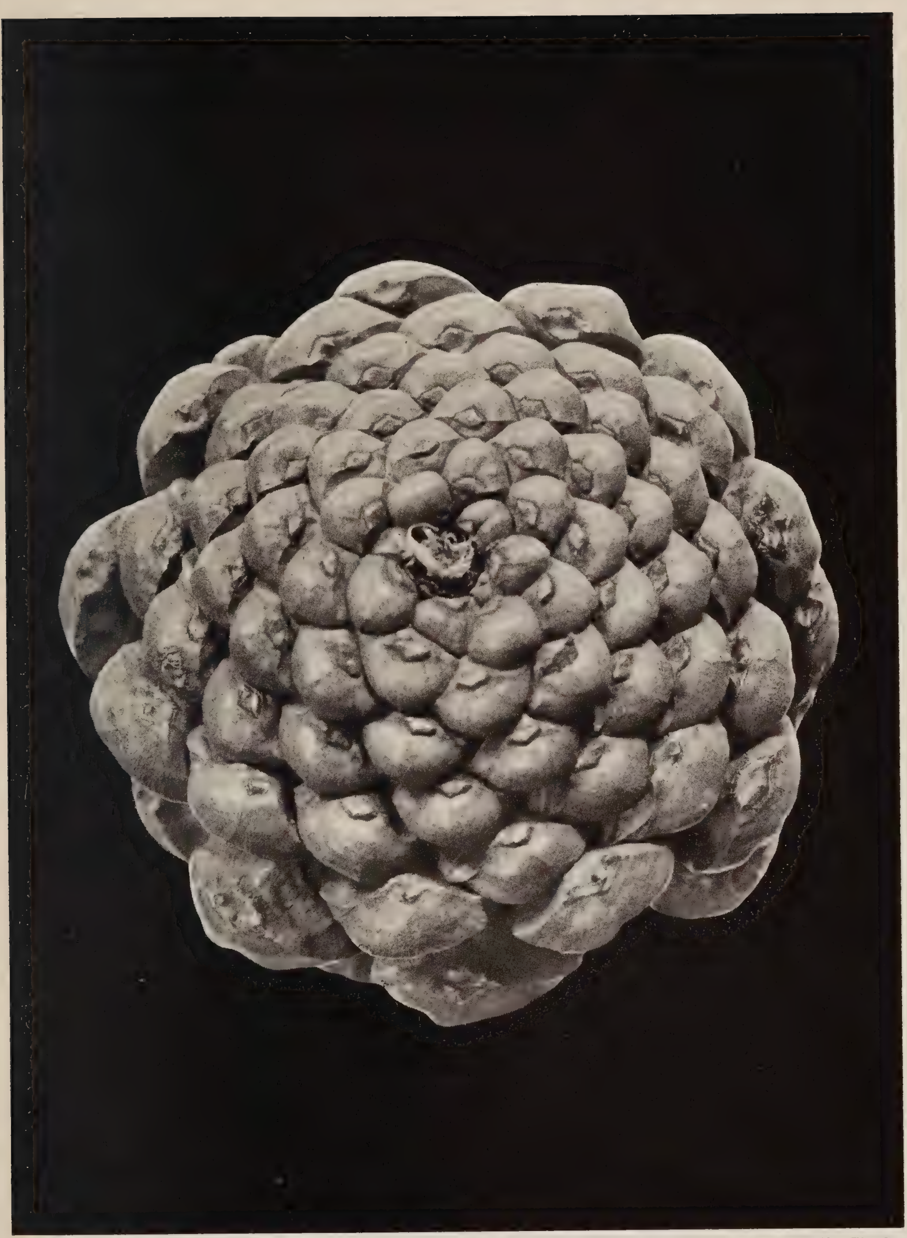
Plato said, "Rhythm and harmony find their way into the inmost places of the soul on which they mightily fasten, imparting grace and making the soul of him who is rightly educated graceful, or of him who is ill-educated ungraceful." [37] Centers of training in the rhythmic movement of the human body have of late been increasing, especially in this country and in Germany. To the extent that these centers have been fundamental in their training there has been, undoubtedly, an increase in the number of persons who, with the conviction of experience, can make statements regarding the vital effects of such training. There is, I believe, growing witness to the claim that in the coördinated rhythmic movement of one's whole organism one may find a vehicle for expressing wholeness, poise, balance, strength, sequence, continuity; also expansion or openness as contrasted with cramp and congestion, and grace and graciousness as contrasted with awkwardness and abruptness. It is possible, as many persons of rhythm experience will affirm, to attain a temporary condition of physical poise or balance in which one seems to lose all sense of bodily weight. It is possible to manifest strength without the factor of tension or exercise of the will. It is possible to feel, and to give the appearance of, continuity even when in the physical situation an hiatus must occur. It is possible to attain a carriage in which one feels, and also looks, taller than he is accustomed to do.

---

[37] The Republic.

There are also purely mental experiences which can be carried out in movement; yet I believe these are not worth anything to the individual except as he carries them out in living. These mental experiences can be illustrated in several ways. For example, movement can respond to the feeling of leadership; also to that of group sense whereby one merges his individual contribution with that of others for a common purpose. It can carry out the feeling of endless space as if going on or going forward were possible, without any recognition of obstacles in the way. It is possible through fine clear lines of movement to reveal one's inner understanding of simplicity and fineness of concept. And, in dance or other free expressions of rhythmic movement one can find a medium through which he can prove himself surpassingly joyous and free. Rhythm training has the special purpose, I believe of awakening children to factors of living that are universal; of pointing them towards realization of the oneness of all creation, including man. Its subsidiary purposes include physical coördination and the provision of physical technique which helps the parts of the body to move easily and naturally and increases the range and the variety of their movements.

Havelock Ellis makes strong claims for expression through rhythm and dancing as essential parts of human experience.



Cornelia Clarke

AUSTRIAN PINE. THE CONE DERIVES ITS DYNAMIC EFFECT FROM THE NUMERICAL PRINCIPLE UNDERLYING THE ARRANGEMENT OF ITS SCALES

He says, "If we are indifferent to the art of dancing we have failed to understand not merely the supreme manifestation of physical life, but also the supreme symbol of spiritual life." [38] Elsewhere he says that dancing is the only art of which we ourselves are the stuff. It is of course natural dance of which he is speaking, not dependent upon though often using the suggestions of musical composition. A little girl in recalling her pleasure in finding seashore shells for the first time said, "I danced!"; and undoubtedly she did dance in the truest sense of the term. Natural dance has been expression for primitive peoples and children as far back as we can go. It seems to have been lost in generations of sophisticated living; but it may be that, with the increase of rhythm teaching in schools and growing recognition of the intrinsic value of such dancing, it will find the place in the present stage of human life which it should rightly have. Nietzsche said,[39] "My style is a dance," and, "Every day I count wasted in which there has been no dancing."

Surely the "style" of normal little children is a dance, manifested joyously on the playground, the seabeach, in the woods, on a walk, wherever they are free; and the more the happy spirit of dancing and its actual expression are allowed to enter into all teaching work and other associations with children, on the part of both the adults and the children, the better will that work be. As Mr. Ellis has said, "Dancing is the loftiest, the most moving, the most beautiful of the arts, because it is no mere translation or abstraction from life, it is life itself." [40] Abundant opportunity should be given to children for dancing, whether in free play, in representation of nature, or in response to the suggestions of music, poetry or stories. Dancing has unlimited possibilities for expressing whimsicalness and fun, the entire gamut of emotion, and abstract form. Best of all, it gives play to the expression of a free spirit.

---

[38] The Dance of Life. p. 10.
[39] Quoted by Havelock Ellis: The Dance of Life. p. 65.
[40] Same. p. 65.

Nature sets the pattern of many a dance. This one, for example, occurs in the realm of space, in the great series of star clouds which make up the Milky Way: "The great majority of the stars whose motion can be measured fall into two groups drifting past one another in opposite directions. . . . The stars forming these two groups are thoroughly well mixed; it is not a case of an inner stream going one way and an outer stream the other. . . . For every two stars in one stream there are three in the other." [41] This is a dance in which one gets not only form but an impression of movement that is slow, steady, sustained, whether or not that is what it is in fact. The same impression is brought to us in our visual concept of the apparent march of sun and moon across the sky; and it comes again in our thought of plant growth. Children in their creative pantomimes love to demonstrate movements of this kind quite as much as they do quick, gay ones, especially if they have had rhythmic training which provides the physical technique for their expression; and they have a capacity for doing it which may seem to the onlooker surprising. "Slowness is beauty," [42] Mr. Ellis quotes Rodin as saying, and he adds the statements that the slowest dances have certainly been to him the most beautiful; and that, in the dance of life, the achievement of a civilization in beauty seems to be in inverse ratio to the rapidity of its pace.

From the birds come other patterns. "High up against the dawn, the sea gulls moved through the stately measures of a dance, slow as an old world minuet. The wings planed in circles without flapping, and the birds met, and passed, and wheeled around and back again, with faultless grace." [43] Mr. Chapman has written thus of chimney swifts, and of pelicans: "There they fly in a great irregular hoop around and around in the air over the chimney. Faster and faster they go, coming nearer to the chimney top. Then like a whirling column of smoke, a part of them pour into the chimney. Then another group darts spirally in. And this is repeated until not a swift remains outside." [44] "I saw in March in Mexico a flock of several thousand white pelicans migrating northward . . . like the hawks their flight was not in a direct line but in a series of intertwining loops . . . they were as dazzling white as snowflakes in a squall, but unlike snowflakes, their motions were as stately and dignified as those of dancers in a minuet." [45] One may see an approximation of dance form in the loops, circles, spirals and figure eights which a flock of pigeons make tirelessly, flashing in and out of the sun-light. Animals and insects provide illustration too; and the pageants of nature already referred to have a close relation to dance in processional form.

---

[41] J. Arthur Thomson: The Outline of Science. vol. I, p. 45.

[42] The Dance of Life. p. v (Preface).

A little girl once separated herself from the group with which she was walking to chase, or rather to play at running after, a yellow butterfly. It was on the open green of a park, with here and there shrubs and flowers, one beautiful day in May. The attention of the other children was caught and they watched her, fascinated, as she moved or paused with the butterfly, circling and turning as it did. Then suddenly as by one impulse the group joined in the play. To the onlooker it was like a perfectly trained group dance. The butterfly leading, the children seemed instinctively to synchronize their movements; the whole group with unconscious grace sailed as one entity across the green, zigzagging, meandering, making sudden changes of course, or halting at flowers, then going on again. It was like the beauty and unison of movement which a flock of birds can show.

---

[43] From an anonymous article in The Christian Science Monitor.

[44] Frank M. Chapman: The Travels of Birds. D. Appleton & Co., 1916.

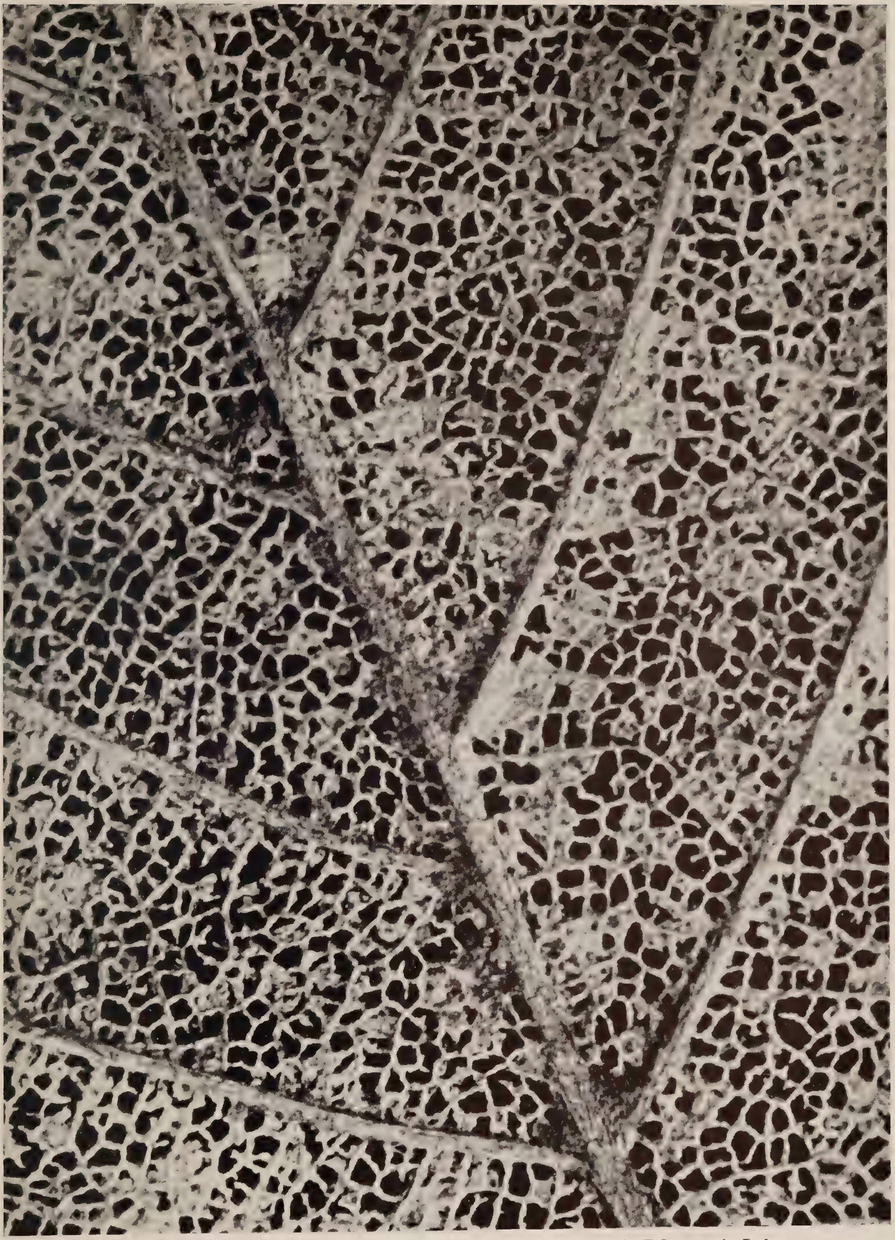
[45] Same. p. 65.

Children's appreciation of action expressed in line, in nature as well as in drawing and sculpture, and their response to the vitality of a work of art are promoted by the development of their rhythm consciousness; and the expressional work which they do themselves is likely to have better line and more life because of it. It is profitable employment in connection with rhythm training to let children reduce to a single line, in thought or in actual drawing, the coördinated movement of a leaping dog, a diver, a wind-blown fountain, the pose of a sculptured gladiator. This method can be applied to representation of all the types of rhythmic movement which the analysis earlier in this chapter set forth. This reduction of form and action to its basic character the Japanese artist regards as law; and certain accepted simplifications have existed for centuries.[46] What is called the fish scale arrangement is applied, for example, to the painting of clusters of pine leaves; specific curves or angles form a series of units which are the basis for representation of mountains, rocks, ledges or cliffs; wheelspoke, pepper, clove, rice, mousefoot and saw-tooth dots, among others, are used in representing the leaves of various trees and shrubs when seen near by, and in distance.

The idea held regarding moving waters is that they "do not permit the eye to seize their exact forms because they

---

[46] See John Bowie: On the Laws of Japanese Painting.



Ernst Fuhrman. In Die Pflanze als Lebewesen, 1930.
Societäts-Verlag, Frankfurt-am-Main, Germany

THE LACE-LIKE DESIGN OF A LEAF SKELETON

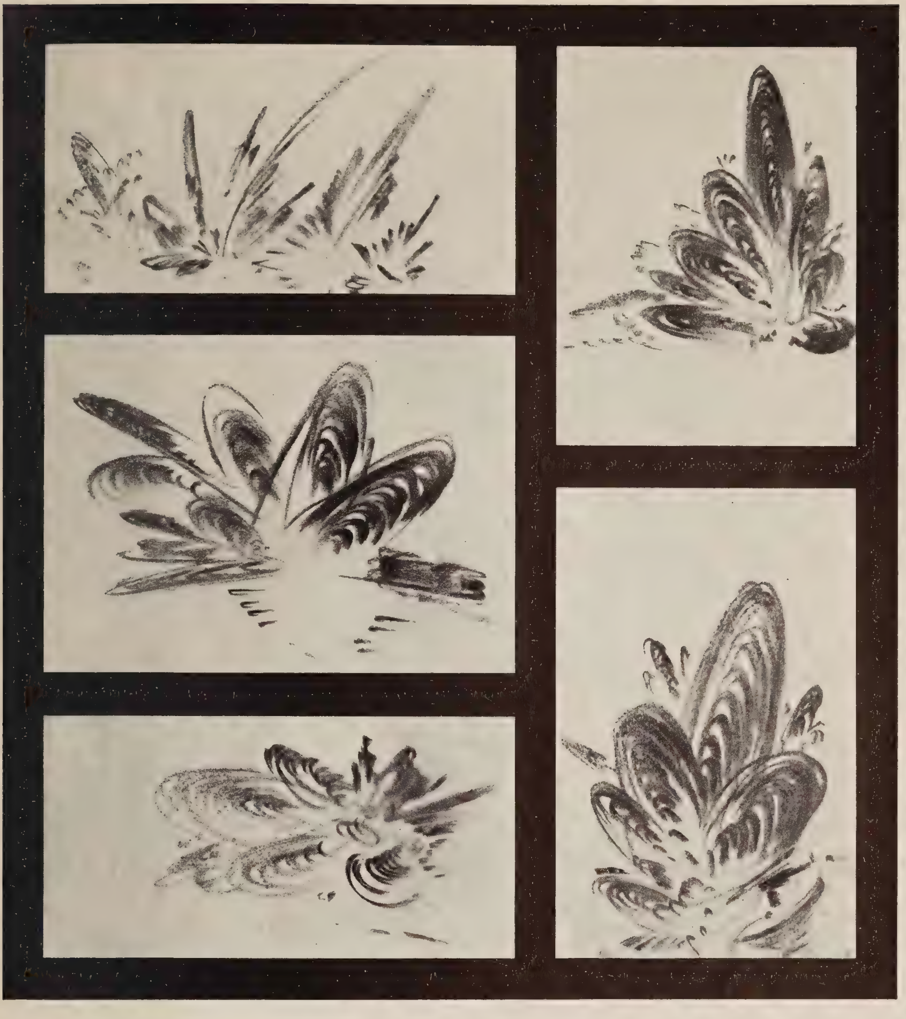
are ever changing and have no fixed, definite shape; therefore they cannot be sketched satisfactorily. Yet, as moving water must be represented in painting, it should be long and minutely contemplated by the artist, and its general character—whether leaping in the brook, flowing in the river, roaring in the cataract, surging in the ocean or lapping the shore—observed and reflected upon, and after the eye and memory are both sufficiently trained and the very soul of the artist saturated, as it were, with the one subject and he feels his whole being calm and composed, he should retire to the privacy of the studio and with the early morning sun to gladden his spirit there attempt to reproduce the movement of the flow; not by copying what he has seen, for the effect would be stiff and wooden, but by symbolizing according to certain laws what he sees and remembers."[47] The folds and lines of a garment are shown by the use of a floating silk thread line, a string line, a running water line, the line of stretched iron wire, the nail-head, rat-tail, broken reed, gnarled knot, whirling water and many other lines. All these symbols or illustrations contribute to one's impression, not only of the Japanese artist's tendency to simplification, but also of his store of intimacy with nature and his recognition of the resemblances referred to in the beginning of this chapter.

Values in appreciation and expression are realized further when children draw trees, geysers, mountains and other objects which are suited to large treatment, working at easels or on a wall, with such freedom that their strokes may be unhampered and swinging, and several feet in length. This has been referred to previously. In representations of the sweeping curves of Mt. Fuji, of trees, and spider-monkeys in large paintings on screens, one gets the impression that the Japanese artist has worked in this way. He seems to have walked with his brush, or flung it about, or drawn it out, in a movement big enough to coördinate his whole organism. It is a kind of drawing or painting which is influenced more by the expression of rhythmic feeling than by the employed sense of sight. The illustrations opposite are the quickly performed work of an adult, a person trained in rhythm. They are included here because they may seem to be an interesting example of rhythmic movement recorded in abstract forms which are living and dynamic, and suggestive perhaps of growth or some other universal principle. Another experience of the expression of rhythm consciousness through drawing results when, with similar freedom and large materials, children draw out the rhythm of a musical composition that is being played to them while they work. McDowell's To a Wild Rose has recurrently resulted in half-circles and circles, superimposed; the Blue Danube, in horizontally placed figure eights.

---

[47] John Bowie: On the Laws of Japanese Painting.

Poetry, the dance, drawing and painting, sculpture, architecture, and music recognize in rhythm a common, basic factor. It can provide for them form and proportion and dynamic quality. Persons rightly trained in rhythmic movement are sure to feel a movement response in looking at vital sculpture. Before the ample statues of the Iris or the supposed Fates of the Eastern Pediment of the Parthenon, or the Dionysos with the Two Satyrs, persons so trained may feel an actual expansion of the thorax, and an accompanying sense of bigness, breadth, freedom and strength in themselves. It is the feeling which they may get also from certain drawings of Isadora Duncan by the Spanish artist José Clará. Also, they may feel a great urge to crawl cautiously forward



THESE DRAWINGS ARE THE WORK OF AN ADULT TRAINED IN RHYTHMIC MOVEMENT BUT NOT IN DRAWING. THEY WERE MADE QUICKLY WITH FREE, RHYTHMIC STROKES. THE FORM WAS NOT PREMEDITATED. THEY SEEM TO POSSESS DYNAMIC QUALITY AND IN ONE INSTANCE TO SUGGEST PLANT GROWTH

with a soft-treading, attenuated panther in bronze; or to stand, still and poised, before a tiny tanagra, possibly expressing in a degree, for themselves, the straight, fine-line feeling of its dignified and exquisite grace.

The teacher of rhythm, working fundamentally, is likely to find that the children worked with have a desire and an ability to model form, in clay or other plastic material, which they did not reveal before they had rhythm training. This training should help children also to appreciate architecture, in so far as its lines and proportions and decorative design are really rhythmic. Of this possible rhythmic aspect of architecture Hawthorne wrote in his American Note-book, "If cities were built by the sound of music, then some edifices would appear to be constructed by grave solemn tunes,—others to have danced forth to light, fantastic airs."

Music is itself inseparable in thought from rhythm. The developed rhythm consciousness may discover in musical compositions their form and patterns, their greater and lesser rhythms, and ideas which can be expressed in movement terms. A little boy said of Debussy's Reflets dans l'Eau, not knowing the subject, "It's like big waves, with little ones dancing on top." Three children after moving to a selection from the Meistersinger expressed themselves in these ways: "It's big and high." "Wide open." "I felt tall, like a captain." A little girl always recognized a phrase in the Largo of the New World Symphony as conveying to her an idea of the sun's rays spreading on and on through space. These are primarily movement responses. They could only in a broad sense be called interpretative. Rhythm training, including moving to music, seems the right approach for children to an important phase of the appreciation and study of music; but since music is a technical subject demanding technical teaching, it is not entered into here.

VIII.

Articulation with a Curriculum

A COURSE of study which is to grip and motivate must grow out of some basic concept. To find a concept of this sort one must go back and back, away from non-essentials, until it stands revealed, apparently proving itself by its wholeness, its simplicity and its application to all times. By such a process of elimination and reduction a seemingly irreducible combination of ideas can be reached: God, man and the universe. These three terms, it may be conceded, comprehend all man's thoughts, relations, activities and means of sustenance. God is a representative term. For some it expresses deity; for others it is synonymous with such phrasing as creative energy, motivating force, primal cause or governing intelligence. It is an idea arrived at in the human consciousness individually, as the result of individual experience; it is not a factor to be dealt with specifically in a curriculum of general education, although the experiences which a curriculum provides may inherently be such as will lead an individual to form his concept regarding it. This leaves for specific curriculum material the study of man and the universe; or in the current terminology of education, social science and natural science. These two subjects constitute the vital part of an outline which follows. The values inherent in both are kept present throughout each school year; but there is variation in their relative apportionment of emphasis and time.

The first chapter of this book has undertaken to state values of natural science study, in so far as they concern children in primary years. The awakening, expanding and deepening of thought which study of natural science can promote belong to all school years from the earliest years of comprehension onward; so also do this study's growing gifts of the experience of beauty and rhythm and of the sense of rational wonder and awareness of natural law. Natural science study, in its capacity to make better individuals, can be credited also with a social value.

What to put early and earliest in a curriculum are important questions. Surely nothing should be put into earlier years which can have greater value to a child if introduced later. It is easy enough to find material in social science and natural science which can interest little children and provide them with the various activities which they need; but before going ahead with it one must have reasonable assurance that the choice he makes is not only workable and valuable but that it is the best possible choice for the children in question at their particular point of development.

Safety may be promoted perhaps by the use of these three tests: (1) Does the material in question seem preëminently fitted to make for the establishment of a good individuality, and to give children a start in forming right attitudes and habits? Modern opinion tends to the idea that these fundamentals should be dealt with even in a pre-school period; and there can be little doubt that they have an important place in the earliest years in school. (2) Is the material in question likely to constitute a wedge of desirable experience which, once put into consciousness, will widen almost inevitably with added years of living? If so, the sooner it is put there the better. The concept of beauty can be thought of as such a wedge; so also the consciousness of universal rhythm, and awareness of the orderly, unfolding wonder of the universal creation. Lives can be finer and more meaningful, more resourceful and more social if experience in these things can begin in them early. (3) Has cognizance been taken of the fact that children's spiritual nature manifests itself readily in primary years? In connection with this third question comes another: Has subject matter been chosen in which this manifested spiritual nature can find most response and opportunity for growth?

Apart from subject matter, but important to these early years of education is the right of children to acquire tools and skills, suited to their development, whereby they can add to their opportunities for independent pleasure and research, and for participation in general. Mastery of reading and writing and of number facts and principles, and the acquirement of motor control, provide such tools and skills.

In evaluating the formulations of the outline the reader is asked to keep in mind certain major considerations on which it is based. In the first place the plan has been built upon the belief that each school year should have a central interest, and that specific values which can be brought out through this interest should be thought of in relation to each school year. Subject matter is considered as means to these ends. It has been the aim in accordance with ideas already stated to place all subjects or experiences at the stage of children's development which these seem to fit best; to give children at the earliest stage of comprehension a measure of realization of their own setting in time and space; and to provide for them a general setting or framework into which any selected events or regions may be seen to fit. I believe that placing of this sort satisfies for children a natural mental demand to have their bearings. It has seemed worth while to keep in the foreground of children's thinking the relation of parts to wholes; and to help children to discover continuity in the unfolded view of animate and inanimate systems.

The plan which is here outlined concerns a lower school; but in order that questions concerning apparent gaps may be answered and that the relation of early to later study may be shown, a very brief supplement for an upper school, undifferentiated for grades or years, has been appended. The primary purpose of the outline is to show how the universe study advocated in this book for certain grades or years, can articulate with the other subject matter of a school's curriculum plan. No reference is made in this outline to the factors of language, mathematics, arts and crafts, and physical training which would appear in a program aiming to present completeness. These are referred to in paragraphs which follow. Applied science has been included because it is based upon natural law.

As the outline shows, a start is made in the kindergarten with individual and group experiences and the beginnings of community acquaintance; in the first grade, school and community experiences are extended. In the three following years mental boundaries enlarge to encompass the earth and the universe, to learn the earth's relation to other bodies in space, and to study the earth and its people. From this point—that is, from the fifth grade on—history holds the central place in interest. Beginning with the birth of the world it climbs to the present, though returning to give special attention to spots which seem to demand it. In this way of working, the present day's level of attainment can be seen in perspective; and it can be thought of as the starting place for infinite journeys beyond.

The first connected experience of history has been assigned to the fifth grade, in the outline. A view of the story of mankind is presented at this point in order to give a setting for all that follows. To keep this view clear and sufficiently comprehensive, a listing of principal events and the provision of some sort of graph to show their time relations is needed. Children at this age can make at most three or four real studies in the course of a year. Out of the many topics which might be chosen, it seems necessary to select only a few for intensive study and to let the list and the graph take care of the rest. It will be seen that two general modes of procedure used successively have been proposed in the curriculum plan as a whole. The first is, in consciousness, horizontal viewing; it is a panorama of the here and now. The second is vertical, showing the relation of the now to what has been and possibly will be. The two concepts are needed to anchor thought intelligently in space and time.

	Social Science	*Natural Science*
Kindergarten	Play and occupational experiences which develop individuality and group sense, and promote the establishment of good mental and physical habits. Definite values but no set subjects. Excursions into the community.	Nature experiences and observations, including gardening, care of animals, walks. Recognition of seasonal changes. Woods experiences. Excursions.
First Grade	Play and construction with reference to village and farm, and local living situations. Other objective activities. Development of individuality and growth in group, school and	Kindergarten experiences continued and extended.

	Social Science	*Natural Science*
	community participation and standards.	
Second Grade	Social values of first grade continued and extended. Development of world sense and cosmic sense. Development of outgoing attitude to strangers. Training in hospitality to school guests. Correspondence with children of other localities to exchange natural products. Pupil experiences in teaching.	Earth study. Experiences which bring children into the beginning of awareness of the unity, order and organization of the physical universe; also of its unfolding variety and beauty, and of the operation of natural law. Study of the earth and other bodies in space and the earth's relation to them. Study of the earth's interior. Consideration of cosmic factors which affect life on the earth. Realization that the concepts of science change. Development of scientific attitude. Play with scientific tools such as prism, magnet, magnifier. Subject material for the year to be drawn principally from astronomy, geology, physiography and from the science of plant and animal life. Woods experiences, gardening, care of animals. (See Chapters III, IV.)

	Social Science	*Natural Science*
Third Grade	Values of second grade continued and extended. World sense deepened.	Earth study and its values continued. Study of the earth's surface and its atmosphere with special reference to great earth rhythms, cycles and sequences and resultant changes; to interrelations and to the law of conservation. Panoramic concept of the whole earth's topography and special study of certain features. Subject material for the year to be drawn from geology, physiography, and meteorology; also from the science of plant and animal life, including marine life. Woods experiences, gardening, care of animals. Seashore experience if possible. (See Chapters V, VI.)
Fourth Grade	World human geography, providing a panoramic view of the countries of the world and their people today. Study of transportation. Development of the sense of international relationship;	Study of topography and climate and other factors of physical environment with reference to variations in human, animal and plant life. Adaptations to environment and human modifications

	Social Science	*Natural Science*
	also of desire for understanding and appreciation with reference to foreign peoples. Exchange social correspondence with children of other lands. Class organization. Committee work with reference to the school as a whole.	of it. Consideration of applied science with reference to agriculture, industry and commerce in various countries, bringing out contrasts. Simple experimentation with physical and chemical law. Woods experiences, country hikes, gardening, care of animals.
Fifth Grade	The story of mankind from the earliest conjectured beginning to the present. This, in the simplest possible terms, to show the spread of population and the causes for divergent languages, customs and physical appearances; and to give some idea of the evolution of civilization. Provision of a mental setting or frame-work for placing separate events and showing time relations. Consideration of outstanding events, and study of some of these. (See paragraph preceding this outline.) Special attention but not dis-	Review of the theory of the earth's origin. Study of the geological records of plant, animal and human life. Consideration of organic evolution including reproduction. Use of subject material drawn from geology, biology, anthropology. Tracing through history the development of some practical scientific invention; and special reference to the scientific achievement of civilizations studied. Extension of experimentation in the field of common science, care of animals, woods experiences, country hikes, camping.

	Social Science	*Natural Science*
	proportionate value to be given to the opening up of the North American continent and the formation of the United States. Continued class organization and school committee work.	
Sixth Grade	Greek civilization in the fifth century B.C. studied intensively for its inherent value and because it attained a signally high point in human development and can serve as a base for comparison when the attainments of the United States and other countries are studied. School committee work continued. Also class organization if needed.	Scientific experiments based on the discoveries and inventions of the Greeks. These include: sundial, compass, measurement of the earth's circumference, Archimedes' principle, geometry, the monochord and perhaps the theory of dynamic symmetry. Other science work, to fit any need that may be manifested. Woods experiences, country hikes, camping.
Seventh Grade	The study of the development of the United States beginning with the earliest history of the North American continent and including European migration and settlement. Special ref-	Applied science, with emphasis upon underlying natural law. Principles of mechanics, power driven motors, electrical appliances for radio, telegraph, telephone, and household electrical accessories.

	Social Science	*Natural Science*
	erence to the parts which labor, immigration, industrial development and scientific invention have played in this country's history; and to civic standards. Participation in some local, state or national enterprise for civic improvement.	The science of photography, using nature subjects largely. Mechanical repair work at school and at home. Woods experiences, country hikes, camping.
Eighth Grade and Upper School	United States political history, including study of the principles of economics, sociology, civics. History of the development of European, far eastern and southern nations. Modern world history with attention to matters of international relationship such as transportation, trade, finance, international law, war, arbitration, language and nationalism.	Physics and chemistry, geology, and biology (or zoölogy or botany) from the research approach with laboratory and field work. Free use of a microscope. Study of matter and energy. Generalizations concerning the natural order based upon research experiences. An integrated concept of nature as a whole. Familiarity with scientific periodical publications, also with national and state government bulletins and services in the science field. Hikes. Camping. Travel.

A synthesis of all the values of social science and natural science experience gained throughout lower and upper schools. Deepened cosmic sense.

The social science and natural science interests as provided for here in successive school years should educate boys and girls in science, geography, history, civics, and accurate English expression; also in rhythmic movement and in literature, if the teaching takes advantage of the ever present opportunities to use literature to convey quality or to make impressions clear. These interests should awaken children to beauty and other meanings and cause the flow of individual expression through varied media, such as drawing, painting, dyeing, modeling and construction; also through poetry and other literary forms, dramatization, dance, or musical composition. They should give children lasting resources for leisure, especially in the enjoyment of the out-of-doors. There are, however, certain desirable educational factors which they do not necessarily motivate or lead to. These factors may include the experience of practical building and construction with large materials, with its demands for physical precision and large-muscled activity, and the opportunity it provides for the satisfaction of making something that can be used; the experience of mastering a fine handicraft with its values in manual skill and a high standard of manual accomplishment; adequate attention to the development of the body, and to the development of the play spirit through active sports; and training in music with reference to appreciation and participation.

While some of these activities may find their way into a broad interpretation of social science and natural science study, they are too important to be left to chance. It is true that craft and construction, if not sufficiently motivated by the suggested subject interests of the outline, are likely to receive much impulse from the practical daily needs of a group in connection with care of materials and pets, in settings and properties for dramatic presentations, or in the apparatus desired for play or convenience. Specific training in these activities, with technique as its objective, is a matter apart and must be dealt with as such. All real values should be taken care of without overdue insistence upon obvious correlation with the subjects studied.

The plan as a whole, covering lower and upper schools, seeks to introduce subject matter so far as possible through actual experience so that it may produce in children direct feeling reactions. Such experience is likely to bring out an interest which leads children to delve for facts; and the resultant of these two types of experience, direct reaction and research, can be a synthesis of ideas which can have practical value in enlarged understanding, in increase of enjoyments, and in the setting up of standards.

Mr. Whitehead in his Rhythm of Education [1] names three factors which he believes should be found to some extent in any period of a child's education. These are romance, precision and generalization. According to his brochure, these experiences in the fields of science, history and language are to be assigned to specific age periods. The successive stages of romance, precision and generalization in any one of these fields, Mr. Whitehead says, constitute a cycle of growth. He cautions against too sharp a distinction between the stages of a cycle. He says, "I mean throughout a distinction of emphasis, of pervasive quality—romance, precision, generalization are all present throughout. But there is an alternation of dominance and it is the alternation which constitutes the cycles." A recent contributor to the New Republic [2] points out that in an improved educational situation we shall think of the experience of the acquirement of knowledge as continuous and expanding; that there will be no place for such expressions as finishing a subject or taking up a new one.

---

[1] Christopher's. London, W.I.

[2] Francis M. Froehlicher. June, 1930.

The primary purpose of this book is to set forth the value which can be derived from studying the physical universe in its wholeness and making it, for a time, the central thought interest. The curriculum plan outlined above assigns to this study first place in second and third grades, a period which most modern schools of the class termed progressive give over to the subject of primitive man or certain phases of community study. Some schools think they have considered the claims of the universe sufficiently for this age when they put primitive man or community study in the foreground and relate these subjects to nature knowledge and experience wherever they seem to point that way. But universe study treated thus is an adjunct and not a base. There must be a right time in a child's life for relating him consciously to the wonder, order and beauty of the coördinated cosmos of which he is part.

The position which this book takes is that, to effect this conscious relationship and to promote an awareness sufficient to influence the quality of a child's after-life, the study of the universe must at a certain period in early education be given predominance; and its abundant content should not have to struggle for place beside another content drawn from a different field. I am convinced that nothing less than straight out, whole, coördinated dealing with universe study can put it into consciousness as soon as it belongs there or can adequately bestow the deep and lasting benefits which it insures. The first chapter of this book has attempted to show what these benefits are, and it has stated reasons for presenting this study in second and third grades to children who are seven, eight or nine years old.

Community study, by the plan here outlined, seems to have been taken care of. It occupies children's thought in the kindergarten and the first grade; and its values recur in the civics and history which all grades beyond the third include. Regarding the study of primitive man it is my belief that, although children easily respond to and enjoy dramatizing knowledge of primitive types, the message of primitive man is not sufficient to permit it to occupy a large share of children's thought in the golden age of their responsiveness. Values acknowledged for it have by the plan submitted some opportunity for realization in the fourth grade when human geography is studied, since a view of the peoples of the earth today discloses a variety of primitive groups. Further opportunity for these values is offered in the fifth grade; for, in the outline of history as planned, primitive man is shown in his place on the social ladder of the centuries. I would agree with the opinion sometimes expressed that there is a primitive element in the free play of normal little children. This seems understandable and natural and worthy of recognition. But does the expression of this primitive element require a teacher's or other adult's time, thought and participation, or place in a curriculum, to the exclusion of greater values?

It is undoubtedly the social values in both these subjects, the community and primitive man, which constitute their chief appeal to adults as material for young children. But is there any higher social value than that which makes for an improved individual? Has not universe study this higher social value if it can make individuals finer in their feeling, more open-minded, broader in their understanding, and better equipped to share experience? And that, I believe, is just what universe study of the right sort can do. Fortunately whatever subject may be selected for special consideration and study, all children in their family life, their class group, and their other social relationships have all the opportunity that could be needed for a continuing development in the ethical and friendly conduct of their own human affairs.

The matter of mathematics calls for special consideration. Ideas of numbers appear commonly in games, play, work and other experiences of childhood. It is customary to make mathematics, especially through the media of play and practical application, a part of the program of all school years from kindergarten up. The value of doing this is conceded generally. But there is a deeper, wider significance for mathematics teaching than such plans are likely to involve. Chapter VII of this book has referred to the relation of mathematics to form in nature; it has recalled the obvious connection between mathematics and the form or pattern in music and dance; and it has pointed out the tendency of modern graphic and plastic arts to recognize a mathematical base. The meaning of this must be that mathematics is believed to embody principles by which beauty and vitality can be evoked.

But scientists and philosophers go farther than this. Fifty years ago the language of pure mathematics was thought of as the nearest approach conceivable to a mutually understood means of universal communication. It was at that time proposed to attempt to speak to Mars through a chain of bonfires to be lighted in the Sahara, in the form of a diagram illustrating a geometric theorem which Pythagoras evolved.[3] Sir James Jeans says speculatively with regard to the author of creation, if there be one: "We have already considered with disfavor the possibility of the universe having been planned by a biologist or an engineer; from the intrinsic evidence of his creation the great architect of the universe now begins to appear as a pure mathematician." [4] Mr. Whitehead says, "The pursuit of mathematics is a divine madness of the human spirit, a refuge from the goading urgency of contingent happenings"; [5] also that "Nothing is more impressive than the fact that, as mathematics withdrew increasingly into the upper regions of even greater extremes of abstract thought, it returned back to earth with a corresponding growth of importance for the analysis of concrete thought." [6] Mr. Eddington has said, "I know of passages written in mathematical symbols which in their sublimity might vie with Rupert Brooke's sonnet." [7] "Number," Philo said, "is the mediator between the corporeal and the incorporeal." [8] Regarding the interrelation of the universe and man Jeans has made this statement: "We discover that the universe shows evidence of a designing or controlling power that has something in common with our own individual minds . . . the tendency to think in the way which, for want of a better word, we describe as mathematical." [9] Is it perhaps true that when ideas are reduced to the laws which they rest upon, they tend to show their amenability to mathematical statement; and that this can apply to physical science, mathematics, economics, ethics, art and other fields of experience?

---

[3] See Sir James Jeans: The Mysterious Universe. The Macmillan Co., 1930. p. 143.

[4] Same. p. 144.
[5] Science and The Modern World, p. 31.
[6] Same. p. 46.
[7] Nature of the Physical World. p. 320.
[8] See L. S. Cook: Geometrical Psychology. G. Redway, 1881. p. 9.
[9] The Mysterious Universe. p. 159.

A layman can be arrested by this trend of thinking even if he is not yet satisfied with regard to its meaning. We realize of course that certain formulations and mental experiences may be intelligible only to persons who are ready for them by reason of mature development and the long road of study and application, and probably by special mental aptitude; and we may expect to find these ideas far from the grasp of children. Yet one is left wondering if there is not some phase or part or intimation of this deeper significance of mathematics which can reach the children of elementary schools, in the formative years of living. We have to think of the formal education of the mass of adult humanity, at present, in terms of the elementary grades; for the great majority of persons do not remain in school beyond these. If mathematics has all the meaning claimed for it, can it be right that children should pass out of school without an inkling that it exists? Perhaps when the desire to convey such meaning is felt and expressed by educators generally useful suggestions for doing it will come from dependable sources.

And if some measure of understanding of mathematical principles can be promoted generally, is it not possible that individual thinking may be affected thereby in practical ways? That is, may it not consciously tend to follow mathematical procedure? May not lines of action in social conduct become clearer and more consistent, with social benefits resulting? Already and commonly we accept as axiomatic certain ideas which are mathematical at base; for example, that an error in the premise means an error in the conclusion; that an uncorrected mistake, small in the beginning, may develop a mountain of trouble; that so long as identical procedure is followed with given factors, identical results will follow—and that to change the result we must change the procedure or the factors; that one cannot get something from nothing.

The summarized meaning of this course of study outline and of this book is that man and natural law are associated inseparably; that the universe including man is one coordinated system; that man and the universe must be considered together in any educational plan that is basic, vital and complete. Thus, in the largest sense, natural science and social science are one interwoven whole. Man, though different from the rest of creation in that through thinking he has power to change his environment, is still subject to underlying, unchanging laws in all that he does. He learns what these laws are, and works with them. Study of the cosmos of which man is part brings out one transcendent idea. This is the idea of order. In a standard dictionary we read concerning the cosmos, "It is the world or universe considered as a system, perfect in order and arrangement, opposed to chaos." Walt Whitman has stated it this way:

There is that in me—I do not know what it is—but I know it
 is in me. . . .

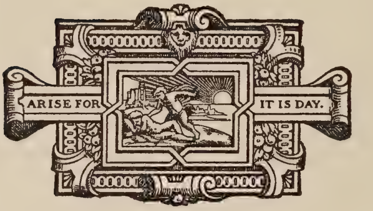
Something it swings on more than the earth I swing on;

To it the creation is the friend whose embracing awakes
 me. . . .

Do you see, O my brothers and sisters?

It is not chaos or death—it is form, union, plan—it is eternal
 life—it is happiness.

THE
JOHN DAY


ARISE FOR
IT IS DAY.

COMPANY
INC.

Date Due

MAR 4 1949			
~~JUL 30 '57~~			

LB1585 .S84
Child and universe,
Princeton Theological Seminary-Speer Library
1 1012 00026 2917